Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

FOR ALL POWER ENGINEERS • STEAM, ELECTRICITY AND ALL OTHER POWER ENGINEERING SERVICES

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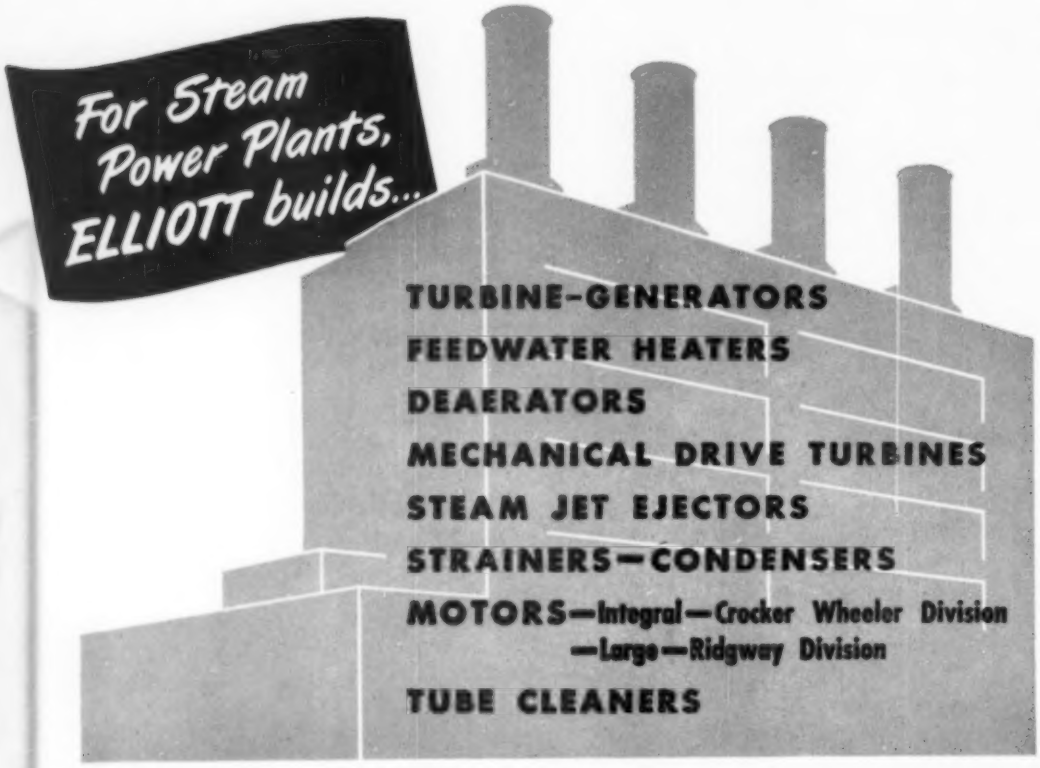
AUGUST 1950

TECHNICAL PUBLISHING COMPANY • CHICAGO, ILLINOIS

A nameplate you see



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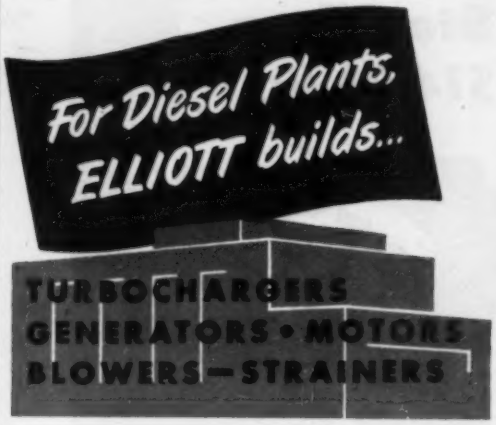

Almost everywhere that power is made and used, you may come upon the familiar Elliott plate identifying important equipment . . . With it, you will almost invariably find among executives and operating staff, a high degree of satisfaction in the performance of the unit so marked. Reliability as an Elliott characteristic is as soundly established as the equally vital quality of forward-thinking engineering which distinguishes Elliott products.

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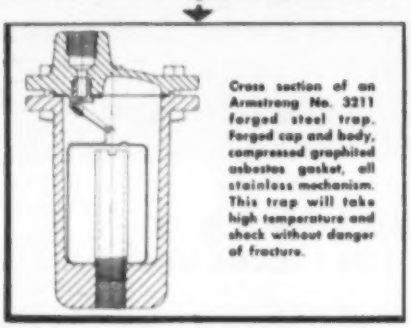

Cross section of an Armstrong No. 3211 forged steel trap. Forged cap and body, compressed graphited asbestos gasket, all stainless mechanism. This trap will take high temperature and shock without danger of fracture.

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Power Engineering

Combining POWER PLANT ENGINEERING and POWER GENERATION

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August 1950

VOLUME 54—NUMBER 8

Notes on This Issue

Burbank's Public Utility Expands

The Municipal power plant at Burbank, California, has long been one of the most talked of small stations in the country. Built in 1939 it incorporates very attractive modern architecture, with semi-outdoor construction and excellent landscaping in such a way as to make it one of the show places in Southern California.

This short article relates the history of the Burbank municipal power development and gives a general description of the new unit. Photographs and drawings, together with a short list of principal equipment, give the reader a good over-all picture of this development.

120 Radial Gas Engines Supply Power to Alcoa Plant

This is a brief description of the new and unusual power plant supplying power to the new Point Comfort Works of the Aluminum Company of America near Port Lavaca.

This is one of the most unusual power installations in the world. It consists of three power houses, each containing 40 radial, 11-cylinder, spark ignited, gas engines. These engines were developed by Nordberg Mfg. Co. and we described them in the November 1948 issue.

Examples of Condensate Contamination

This is a very interesting report of four cases of severe condensation, all in paper mills but of a character which might occur in other industries. All of these cases occurred unexpectedly and caused a great deal of trouble before their source was disclosed and corrective measures taken.

As pointed out by Dr. Welsh, unless engineers make a practice of systematically checking certain potential danger spots, trouble of this kind can occur and result in loss of production and sometimes serious damage.

The Flux Algebra

Here is an absolutely new method of calculating heat transfer by radiation which greatly simplifies the procedure over conventional methods of calculation.

Elliott Boiler Plant Installed Without Interrupting Service

This short, illustrated, description of the new boiler plant at the Elliott Company at its Jeanette works explains how the old plant was kept running while the new installation was being made. Among the devices used to insure uninterrupted service was the use of a Pennsylvania locomotive. By connecting the stack of this locomotive to an induced draft fan in the roof of the building, it was able to supply steam while the new boilers were being installed.

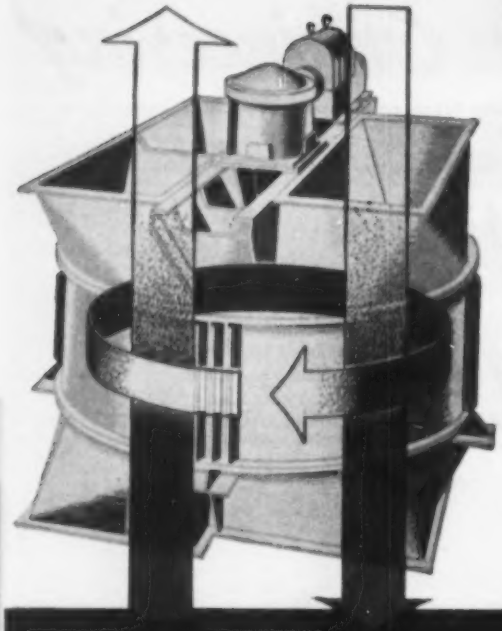
The Continuous Flow Conveyor

Here are some little known facts about a relatively new type of conveyor that has been found very useful under many different conditions in meeting power house requirements for coal handling. It causes a mass of material to move along in a closed duct, not by pushing or pulling it along but primarily by creating a mass flow in the material itself by dragging spaced frames or skeleton flights through the material by means of a chain cable.

The author gives a number of typical examples of how the conveyor proves better for certain problems than other types. He shows what precautions must be used in laying it out, discusses some operating pointers, gives charts and tables for figuring the capacity and power requirements of the continuous flow conveyor.

Moisture in Coal

In the March issue, a reader asked about measurement of moisture in coal under Question No. 457, and several interesting answers from readers have been published on that subject. The present article is an amplification of those answers. It reviews first the proper tempering of coal and then gives a method the author has found satisfactory and accurate for measuring moisture in coal.



this preheater can save you money whatever your fuel

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The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves the heat is transferred from the waste gases to the incoming cold air.

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The efficiency and reliability of the Ljungstrom air preheater is a matter of record in industrial and utility plants throughout the country. That is why every year a constantly increasing percentage of the installed boiler capacity is equipped with Ljungstrom air preheaters.

If you are planning a new installation, or modernizing your present one, our engineers will welcome the opportunity to show you how the Ljungstrom can raise the efficiency of your plant.

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ENGINEERS' PREVIEW

ACCOMPANYING the nation-wide expansion of apprentice training in American industry, much interest is being shown today in the origin and history of apprenticeship, not only by those participating in the training, such as employers, laborers and representatives of vocational education, but also by the general public. An interesting little pamphlet entitled Apprenticeship Past and Present tells the story of apprentice training in the skilled trades in this country since the colonial days. Copies of it may be obtained for 15 cents each from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The booklet is published by the U. S. Department of Labor, Bureau of Apprenticeship.

★ ★ ★

VISITORS to Washington this spring and summer, either on pleasure or business—and, of course, the Washingtonians themselves—have been fascinated by the repair work they can see under way in the White House. It is doubtful, however, if many of the observers of this work realize that this is the house that nearly fell. If you doubt this, you ought to read the very fine article under that title, The House That Nearly Fell by E. John Long, in *Steelways* for May 1950. Mr. Long writes current history at the Pentagon but combines a steel-town background with a thorough knowledge of Washington. In a very well-illustrated story showing some of the repair and reconstruction work now going on, Mr. Long demonstrates how the executive mansion was a death trap behind its paint and plaster. But now, inside the familiar outer walls, with the aid of modern steel construction, workmen are building a modern White House.

There have been numerous newspaper and general magazine stories about this reconstruction, but so far we have not seen anywhere else an article that gives the technical details of the extensive reconstruction work that is going on in our country's executive mansion. The majority of the people who expressed opinions on the subject were opposed to tearing down the White House and erecting a new one. Everybody said "Let's rebuild it and make it strong, but preserve its outward appearance no matter what the cost." That is what is being done and the contractors are confident that in the fall of 1951 they will be able to offer the President and his family a safe home, that, in the words of George Washington, "will have the sumptuousness of a palace, the convenience of a house, and the agreeableness of a country seat."

★ ★ ★

THE M. W. KELLOGG COMPANY, of Jersey City and New York, announced in June that the company had sold the stock and assets of one of its subsidiaries—The Kellex Corp.—to The Vitro Manufacturing Co. This step is in accord with Kellogg's policy of concentrating its commercial development, engineering and manufacturing efforts in the petroleum, chemical and power fields and of confining its governmental contracts to development engineering and manufacturing in the fields of jet propulsion, guided missiles, and so on. These latter activities are conducted by Kellogg's Special Projects Division in Jersey City. Contracts currently held by Kellex, primarily in the field of atomic energy development, will be continued by that organization.

DR. ROBERT E. DOHERTY, third president of Carnegie Institute of Technology of Pittsburgh, Pa., retired from the presidency on July 1, 1950. He became president in March 1936 and his achievements during 14 years as president of Carnegie have established him in the eyes of his fellow educators as one of the nation's educational pioneers and as an administrator of the first order. In 1936 he inaugurated the Carnegie plan of professional education and during his tenure as president he doubled Carnegie's endowment and was repeatedly successful in raising current or operating funds for special projects. As an administrator, Dr. Doherty was always clear in his policies and in his plans for following them. He re-organized major divisions and departments; and set up the structure for effective liaison between faculty and administration, between Carnegie and its students and between Carnegie and its publics.

Dr. Doherty was born in 1885 in Clay City, Illinois, received a degree of Bachelor of Science from the University of Illinois in 1909, and from then until 1931 worked for General Electric Co., serving for six years as assistant to Dr. Charles P. Steinmetz. In 1931 he left General Electric to join the Yale University faculty as professor and chairman of the Department of Electrical Engineering. Two years later he was made dean of the Yale School of Engineering and became president of Carnegie in 1936.

In 1943 the Pittsburgh Junior Chamber of Commerce elected him as Man of the Year. He has been very active in the educational programs of professional societies, is a member of various fraternities and honorary societies, and is a fellow of the AIEE and the ASME.

★ ★ ★

ARE YOUR SUPERVISORS superior leaders? Are they top-notch production men? Are they good personnel men? If you cannot answer with a loud YES to all three questions, you can be sure that company money is dripping away like water from a leaky faucet. To help stop such leakage, the National Foremen's Institute, Inc., 100 Garfield Avenue, New London, Conn., is preparing a group of manuals called the *N.F.I. Standard Management Practice Series*, addressed specifically to supervisors. The first three manuals in the series are now ready for shipment as follows: The Foreman's Place in Management, The Foreman's Manpower Job, The Foreman's Production Job. Full information about them can be obtained from the Institute at the above address.

★ ★ ★

A TOUGH new plastic, which promises to become one of the basic raw materials of the rubber industry, has been announced by United States Rubber Co. The new plastic bridges the gap which has existed between soft rubber and hard rubber for almost a century.

Among the other promising applications for the plastic are: fuel pump parts, battery cases, dies and jigs, valve seats, buckets for carrying chemicals, plating barrels, filter press plates, photostat separator plates, tote boxes, bearings, electrical insulators, and various automotive parts such as camshaft timing gears, water pump impellers, ignition coil housings, distributor caps, low-load and low-speed bearings and bushings.

HOW INTOXICATED ANIMALS react when exposed to cold is helping medical science in its search for techniques of survival in the Arctic, according to Dr. Kurt Lange, assistant professor, New York Medical College.

Speaking on a General Electric science forum over WGY he said examination of animals under influence of alcohol has revealed that extreme cold dilates the blood vessels and allows a more rapid heat loss from the body. Alcohol also dulls senses needed to take all possible measures of protection.

He pointed out two common mistaken ideas about cold weather:

1. Rubbing a frostbitten limb with snow or otherwise keeping it cool "aggravates" rather than helps in treatment. Blistering will increase and the area covered will be larger.

2. Human volunteers from the cool north who underwent cold weather tests showed no special resistance to cold. The highest resistance to cold was found in a man born and living in Florida.

★ ★ ★

NEW WRINKLE in burning coal underground in its natural layers, to obtain gases for combustion or for use in making liquid fuels, is added in a process for which a Swedish inventor has received an American patent. The inventor is David Dalin of Sodertalje, Sweden.

In his process, he utilizes the underground fire to heat water to use for power or other purposes. A few extra holes are drilled down into the layer of coal to be burned and circulatory pipes are put in the holes through which water is forced.

His method of obtaining combustible gases from the underground coal is similar to processes already in experimental use in various parts of the world. The American experiment is at Gorgas, Alabama, conducted as a joint project of the U. S. Bureau of Mines and the Alabama Power Co. See *Power Engineering*, May 1950, page 101.

★ ★ ★

LESOCUPETHY is another new science you will probably hear more about in the future. It is a coined name for a science that would integrate four other sciences—(1) behavioristic psychology, in which studies of experimental animals and human beings contribute to our understanding of the learning process; (2) sociology, with its statistical and other studies of social structure; (3) cultural anthropology, the study of cultural behavior principally within isolated primitive cultures; and (4) psychoanalysis and psychiatry, which study the individual personality.

The word "lesocupethy" is coined from LEarning, SOciety, CUlture, and PErsonality THeorY. For a long time workers in the social science have had no over-all theory that would integrate a number of interrelated sciences like this and Dr. G. P. Murdock of Yale has proposed such an integration in an article in *The Scientific Monthly*.

Physical scientists have a more or less consistent overall picture or theory embracing the structure and action of physical matter. In some cases matter is studied by the physicist, in others by the chemist or geologist, but each kind of physical scientist knows that principles derived in the other fields can be applied to his if they are needed, and he finds that often they are needed. This is the sort of integration in the social sciences that is being sought. More explanation of it is given in the July 1950 issue of *Industrial Bulletin* of Arthur D. Little, Inc.

FIRST COMMERCIAL extraction unit employing furfural as the solvent and specifically designed for the production of Diesel and domestic heating fuels has been announced by The Texas Co. Widely used by the oil industry for the removal of sludge producing elements in motor oils, the furfural process has been adapted to the new use in a commerical unit operated by The Texas Company at its new $60,000,000 refinery at Eagle Point, N. J.

Basic value of the new application is seen in substantial improvement of cetane number in Diesel fuels, improved burning quality of domestic heating fuels, and the reduction in sulphur content of all products. This may offer a solution to a major oil industry problem.

★ ★ ★

FOR THE NEW Hudson River Pumping Station being built by New York City's Board of Water Supply at Chelsea, N. Y., about 10 mi south of Poughkeepsie, General Electric will supply approximately $350,000 worth of electric equipment.

Designed to augment the dwindling water shed resources of the nation's largest metropolis, the station will have a discharge rating of 100,000,000 gal of water a day. Water will be drawn from the Hudson River and discharged into the existing Deleware Aqueduct, according to engineers working on the project. The water will be drawn from the river into a 6-ft-diameter conduit which leads to the pumping station. In this conduit it will receive chlorination, the engineers said, and in its chlorinated state enter into the city's regular 13½-ft-diameter water system conduit.

Each of six Peerless pumps to be installed at the station will be powered by a 2500-hp G-E vertical synchronous motor. Five of the pumps will be used to meet the 100-mgd rated capacity, it was said, while the sixth will be held as a spare.

Also G. E. will furnish a package unit substation for the project, including a steel station structure. It will consist of disconnecting switches, an incoming line oil circuit breaker, lightning arresters, an auxiliary transformer, metering equipment, neutral resistors, a master unit substation, and a station battery and charger. The substation is rated 15,000 kva, 3 phase, 60 cycles. The single incoming circuit will be rated at 110,000 volts, while the seven outgoing feeder circuits will be rated at 4160 v each.

★ ★ ★

FEW SUBJECTS interest executives as much today as research administration. The firm of Arthur D. Little, Inc., is now increasingly engaged in applying the experience it has gained in 64 years of industrial research and engineering to the review of its clients' research policies and procedures. To aid its staff members in this work, the organization has prepared a carefully selected bibliography of books and articles on Management of Industrial Research. This bibliography is now available to the public without charge. Address your requests for it to Howard F. Hamacher, Arthur D. Little, Inc., Memorial Drive at Kendall Square, Cambridge 42, Massachusetts.

The bibliography is an attractive 16-page paper bound booklet. After a brief introduction, it gives general references and background of the subject and a list of books and periodicals on the general background. This is followed by lists of books and articles and periodicals on organization, control, the research program in both technical and economical aspects, the research laboratory and miscellaneous. There is a good subject index and a periodical abbreviation key at the end.

1. Yoke Bushing: Hard bronze, lock welded to yoke.

2. Yoke: Forged steel, integral gland rest, screwed and lock welded to bonnet in union type; integral with bonnet in bolted design.

3. Bonnet: Built-in back-seat, big packing chamber; either rolled steel union ring or forged steel stud bolted type.

4. Packing: EValpak, die formed, water-proofed, treated to prevent stem pitting.

5. Gasket: Ironkote 90 Brinnell max. for leak-proof joint.

6. Disk: EValloy 13% chromium or Stellite, slotted or disk nut type, self-centering.

7. Seat: EValloy 13% chromium or Stellite on stainless steel; borized in mated pair with disk.

8. Handwheel: Malleable iron, knobbed for easy gripping.

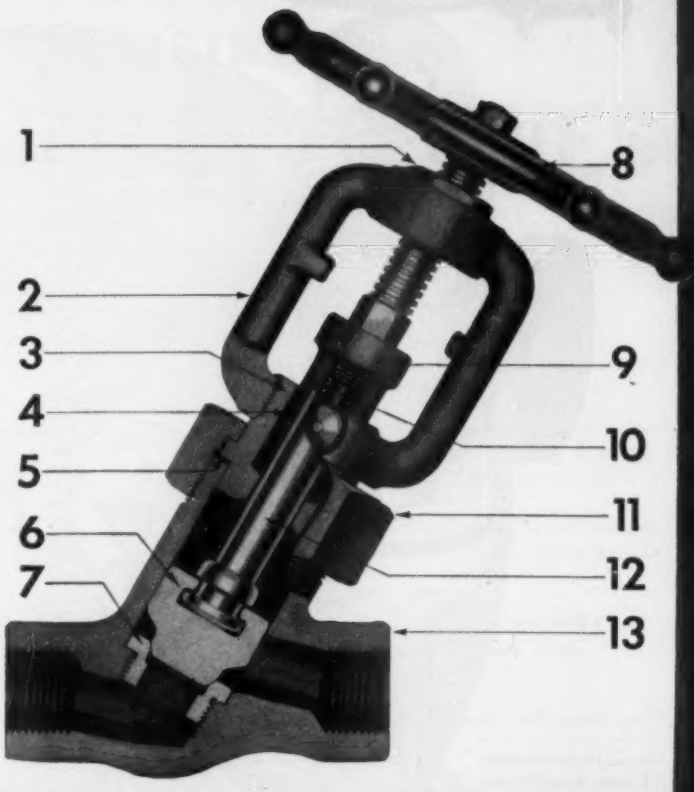
9. Gland: Forged steel, through bolted, accurately fitted to stuffing box.

10. Swing Gland Bolts: Forged steel, EValized for longer, corrosion-free life; swivel out of way but can't come off.

11. Union Ring: Rolled or forged steel, hexagonal.

12. Stem: Hardened, centerless ground EValloy, with backseating shoulder (on disk nut on larger sizes).

13. Body: Heat treated forged steel, inclined stem globe type for lowest pressure loss, screwed or socket welding ends.



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Yarway Type "B" Seatless Tandem Blow-Off Valve. For pressures to 400 psi. Ask for Bulletin B-424.

YARWAY

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1. To be sure of *tight* blow-down lines.

2. To withstand the severe punishment of regular or emergency blowing-down under pressure and periodic acid wash.

Yarway Blow-Off Valves are *good* blow-off valves—designed and built to safeguard beyond any doubt your sizeable boiler investment.

To give you drop-tight protection required for efficient boiler operation, Yarway offers Seatless Valves that have no seat to score, wear, clog and leak . . . or heavy-duty Yarway Stellite Hard-Seat Valves.

Either valve, or any tandem combination, also provides ruggedness and safety beyond any emergency requirements.

It is no coincidence that more than 15,000 boiler plants throughout the world use Yarway Blow-Off Valves . . . and among high pressure plants, 4 out of every 5 are Yarway-equipped.

For the full story on blow-off valves for *your* boilers, write today for the Yarway Bulletin. *Please mention pressure range.*

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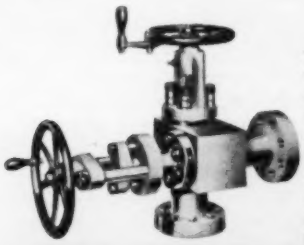
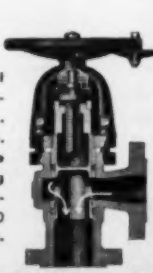


Yarway Unit Tandem Blow-Off Valve. Flanged type. Also available with welding ends. For pressures up to 2500 psi. Ask for Bulletin B-432.



Yarway Type "B" Angle Valve, cross-sectioned in open position. Note balanced sliding plunger design. For pressures to 400 psi. Ask for Bulletin B-424.

Yarway Stellite-Seat Straightway Valve, cross-sectioned in open position. Disc and seat ring are stellite-faced and ground. For pressures to 2500 psi. Ask for Bulletin B-432.

Accurate integration over the entire range in HAGAN

RING BALANCE METERS

This wide range accuracy is due to the unique design and precision construction of the Hagan integrator.

In this integrator, a large toothed wheel is set in motion periodically. The movement at each interval is governed by the flow index pen and is proportional to the momentary rate of flow. The wheel is geared to a counter which registers the total flow through any period, by difference in the counter readings.

The Hagan Integrator differs fundamentally from others in that all associated parts rotate around a common center. As a result, angularity errors are eliminated and only one simple adjustment is required for calibration throughout the range. The large five inch integrating wheel produces the required selectivity to integrate as low as two percent (of chart) with high accuracy. With this construction, wear between toothed wheel and the pawls is eliminated. There are no clutches to wear and slip.

The instantaneous pawl action also produces high accuracy under rapidly fluctuating flow conditions.

The graduations on the large wheel and pointer facilitate checking the calibration of the integrator at any point in the range in one minute or less.

The Hagan Integrator is a self-contained unit and may be mounted conveniently in any of the various types of Ring Balance flow meters, or pneumatic receivers.

For full information on this and other features of Hagan Ring Balance meters, write to Hagan Corporation, Hagan Building, Pittsburgh 30, Penna.

HAGAN HALL BUROMIN CALGON

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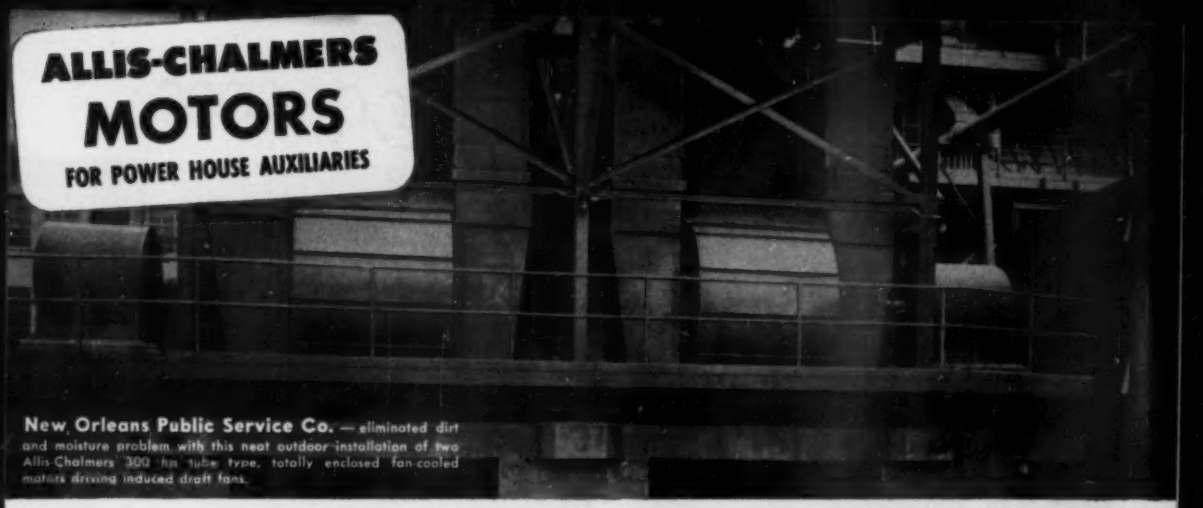
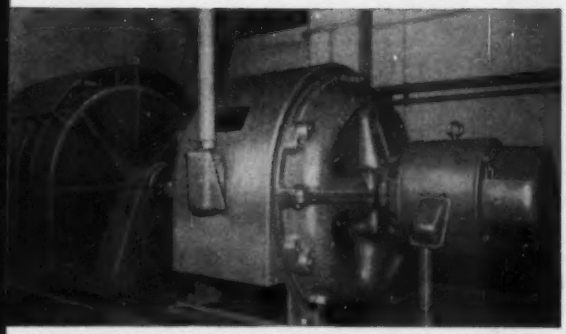
THRUSTORQ FORCE MEASURING DEVICES
BOILER COMBUSTION CONTROL SYSTEMS
METALLURGICAL FURNACE CONTROL SYSTEMS



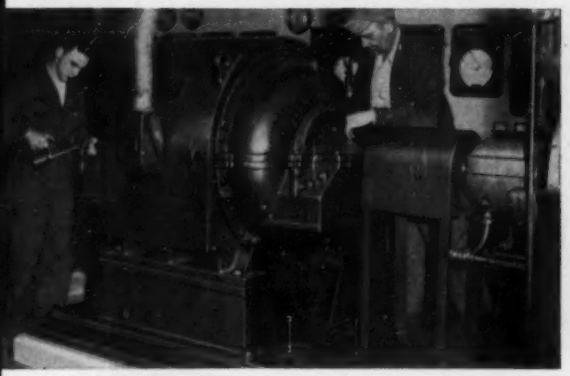
ALLIS-CHALMERS
MOTORS
FOR POWER HOUSE AUXILIARIES

New Orleans Public Service Co. — eliminated dirt and moisture problem with this neat outdoor installation of two Allis-Chalmers 300 hp tube type, totally enclosed fan-cooled motors driving induced draft fans.

Motor Reliability For Toughest Jobs!



Potomac Electric Power Co. — drives induced draft fan through an electric coupling with this 400 hp drip-proof Allis-Chalmers motor.



Kentucky Utilities Co. — uses two of these highly reliable Allis-Chalmers 700 hp two pole motors to drive high pressure boiler feed pumps.

HERE ARE REASONS why utilities like these all over the country are using Allis-Chalmers motors for their auxiliary drives.

First, motors are furnished in every needed type and size. In addition, each motor has features to assure the reliability that power plants need. For example: two pole motors have a pressure vent arrangement in the bearings to prevent oil leakage into the stator in spite of the high speed of the motor.

The tube type, totally enclosed fan-cooled motor has straight heat exchange tubes which are self cleaning under practically all conditions and make the motor ideal for outdoor locations.

Extra varnish treatment is provided in all power house motors to resist moisture and acids — assure long life.

Allis-Chalmers is equipped to build the complete motor-pump-control package. If you intend to modernize or enlarge your facilities, it will pay you to specify Allis-Chalmers. Call your nearby A-C Sales Office for further information.

A-3084

ALLIS-CHALMERS, 953A SO. 70 ST.
MILWAUKEE, WIS.

Toledo Edison Co. — drives condenser pumps with these two 400 hp vertical cage motors.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Sinclair Rubilene Resists Oxidation Gives Long, Low Cost Service

Oxidation attacks oil wherever there is continuous recirculation—in enclosed crankcase systems and, especially, in central circulating systems. It forms damaging acidic compounds, gum, carbon, and sludge. Result: frictional drag is increased, oil lines may become restricted or closed, wear accelerated, efficiency and life lowered.

Many years of experience show Sinclair Rubilene successfully withstands oxidation even under sustained high temperatures. This is due to Rubilene's greater stability and ruggedness. At the same time non-foaming Rubilene assures a solid flow of oil to provide a tough oil cushion between all moving parts. Rubilene thus lessens friction and wear and provides high efficiency and smooth operation.

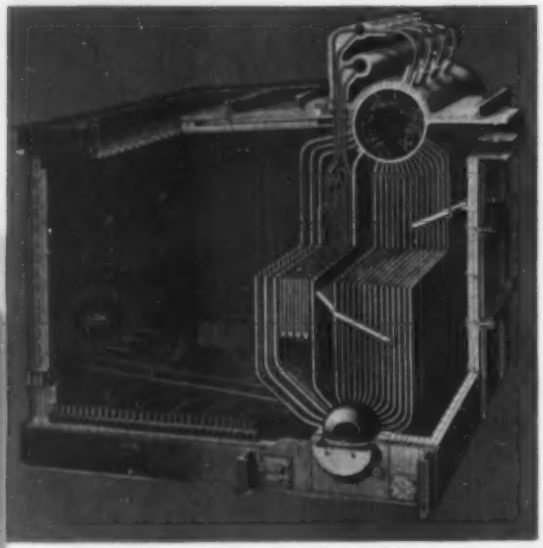
Why not eliminate worry over damaging oxidation and assure reliable lubrication? Use Sinclair Rubilene Oils.

Your nearest Supplier of Sinclair Products will gladly arrange for lubrication counsel, or write to Sinclair Refining Company, 630 Fifth Avenue, New York 20, N. Y.

SINCLAIR

Sustained New-Oil Quality
Long Oil Life
Tough Oil– Less Wear
Circulates Freely
INDUSTRIAL OILS

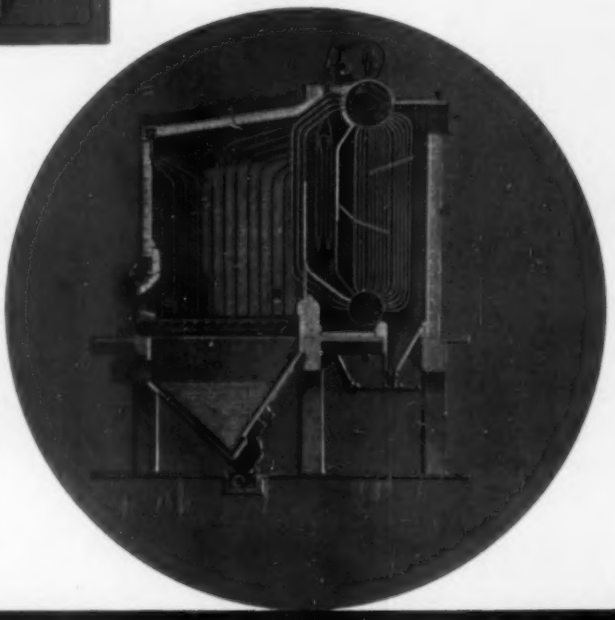
WHICH fits



Type VU-50

(for the higher capacity range)

This unit, the original VU design, may be fired by pulverized coal, oil or gas, or any combination of these fuels. Available for capacities up to 300,000, or more, lb of steam per hr, pressures up to 1000 psi and steam temperatures up to 900 F, or higher. Furnace bottom may be as shown or may be of hopper type. Economizer or air heater surface may be added.



Type VU-30

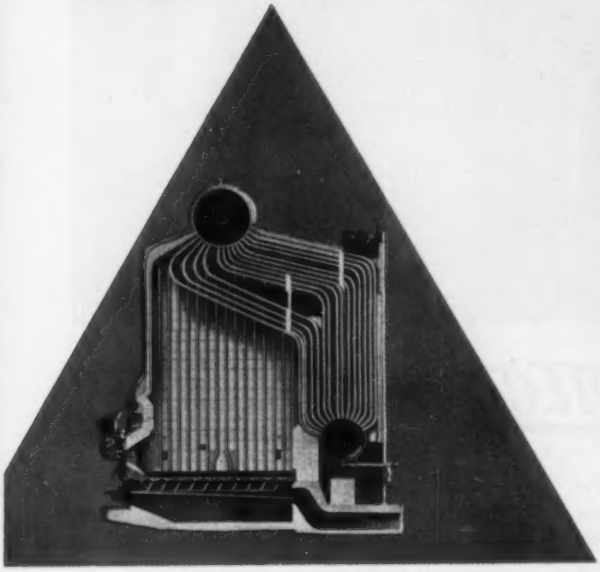
(for the middle capacity range)

In this VU design, shown equipped with a C-E Spreader Stoker, the furnace proportions and arrangement of water wall surfaces may be adapted for firing by any type of mechanical stoker. Design is also adaptable for firing by oil or gas. Economizer or air heater surface may be added. Approximate capacity range 25,000 to 100,000, or more, lb per hr.

COMBUSTION ENGINEERING

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS. ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

Vertical-Unit Boiler <u>your</u> special needs ?



Type VU-10

(for the lower capacity range)

This member of the VU family is designed for industrial load conditions and particularly for plants having small operating and maintenance forces. Capacities range from about 10,000 to 60,000 lb per hr. Firing may be by spreader, underfeed or chain grate stokers, or by oil or gas burners. Superheater, economizer or air heater surface may be added if desired.

No matter what your combination of operating conditions, one of these three units can meet the particular requirements of your plant *exactly*.

CAPACITY: Vertical-Unit Boilers are available for capacities ranging all the way from 10,000 lb of steam per hr up to 300,000 or more lb per hr.

PRESSURES—TEMPERATURES: VU Units are available for steam pressures up to 1000 psi and temperatures up to 900 F, or more.

FUEL REQUIREMENTS: The larger designs may be fired by pulverized coal, oil or gas, or any combination of these fuels. In the medium and lower capacity ranges firing may be by any type of mechanical stoker or oil or gas. Moreover, it is possible to substitute any one of these methods for another should a change in the fuel market occur.

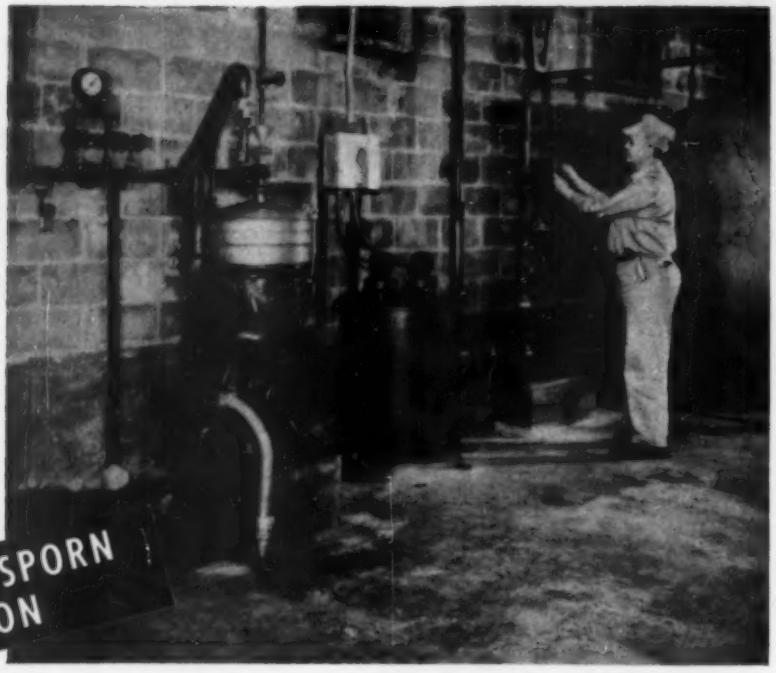
This flexibility . . . this ability to meet the widely varying requirements of plants in virtually every branch of industry — at efficiencies ranging up to 88% — accounts for the wide acceptance of the Vertical-Unit Boiler. Throughout the United States and Canada, Latin America and abroad, the VU has been selected for installations with an aggregate capacity of well over 100,000,000 lb of steam per hour.

Whether you are considering the purchase of equipment for replacement or expansion, or for a new plant, a C-E Vertical-Unit Boiler will provide the right answer to your particular situation. We shall be pleased to supply catalogs and any additional information upon request. 392-A

— SUPERHEATER, INC.

200 MADISON AVENUE NEW YORK 16, N. Y.

C-E



DE LAVAL *PROTECTS* the *TURBINES*

This De Laval centrifugal Oil Purifier installed at Philip Sporn Station provides positive protection for the turbines. It removes from the turbine oil sludge or any solid impurities that may be picked up, and it also separates and continuously discharges any moisture that may be in the oil.

Thus, the De Laval centrifuge provides ***two-way*** protection. It guards the power unit against ***both*** of the chief causes of lubricating oil contamination —dirt and water. Wholly mechanical in operation, De Laval Oil Purifiers are the logical choice of operators who want their oil to be really ***clean and dry***.

A wide range of capacities is available. Machines requiring separate pumps are provided in sizes having a purification capacity up to 1,000 gallons per hour. "Uni-Matic" machines, built with integral pumps, have a capacity up to 450 gph., Navy rating, on turbine oil (up to 550 gph. on certain other oils.)

● Write for additional information.

De Laval

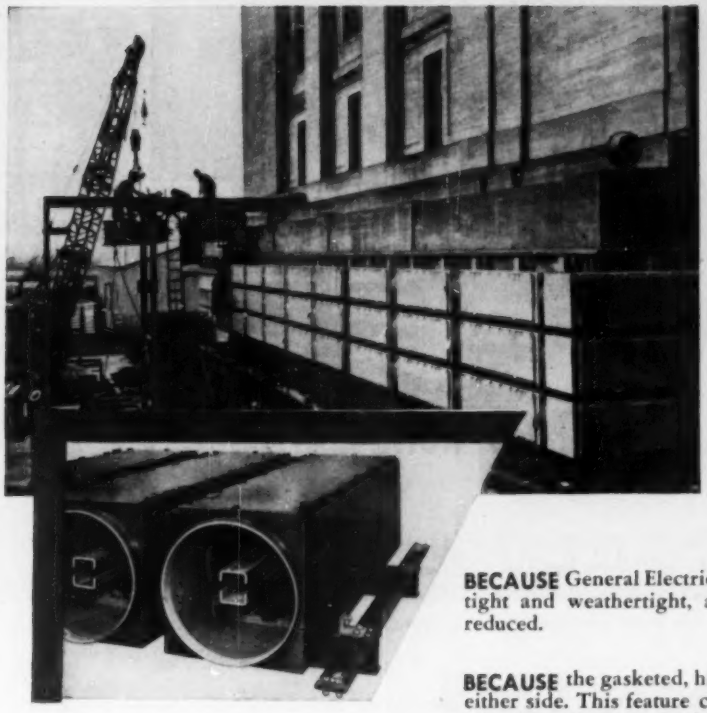
THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 . 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5
THE DE LAVAL COMPANY, Limited, Peterborough, Ont.

LUBRICATING OIL PURIFIERS

11 of the 16 largest turbine-generators*

use

GENERAL ELECTRIC ISOLATED PHASE BUS RUNS



RATINGS
15 and 23 kv
1200 to 7000 amperes

Your G-E Sales Representative has complete information about isolated-phase bus runs. Ask him for a copy of GEA-5460, a 28-page publication that will aid you in planning your bus runs, or write to *Apparatus Department, General Electric Company, Schenectady 5, New York.*

BECAUSE General Electric isolated-phase bus runs are dust-tight and weathertight, and maintenance costs are thus reduced.

BECAUSE the gasketed, hinged covers can be opened from either side. This feature cuts inspection time and costs by allowing access to the interior of the run from the most convenient position. Cover lugs release the cover without removal of bolts. The cover is swung open on either one of two sets of hinges.

BECAUSE you receive G-E isolated-phase bus runs completely assembled as a three-phase package, including running ground bus. They are installed in a short time at lower predictable costs.

BECAUSE you have one source of responsibility when you order from General Electric—complete co-ordination between planning, engineering, manufacturing, and service facilities to give maximum savings efficiency to the customer.

*Installed and planned, rated 6000 amperes and over.

GENERAL ELECTRIC

855-24

This Bailey Boiler Control Panel insures high efficiency in the use of Fuel-Dollars at a Western Chemical Plant.

What's Your Fuel-dollar Efficiency?

A dollar's worth of fuel has the *same potential* energy, no matter who's boiler it fires. But how much of the energy actually gets converted to a usable form depends on how you operate your boiler.

That's where Bailey Controls can help. And, here's why, we believe, you'll get better fuel-dollar efficiency with Bailey:

1. **Complete Range of Equipment—fully co-ordinated.** You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control systems.

2. **Engineering Service—backed by experience.** No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement and automatic control.

3. **Direct Sales-Service—conveniently located near you.** Bailey Meter Company's Sales-Service Engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

•

For better fuel-dollar efficiency—for more power per fuel-dollar, less outage and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More power to you!"

A-109-1

BAILEY METERS

BAILEY METER COMPANY

1040 IVANHOE ROAD
CLEVELAND 10, OHIO

Controls for Steam Plants
COMBUSTION · FEED WATER
TEMPERATURE · PRESSURE
LIQUID LEVEL · FEED PUMPS

Easy local call . . .

Walter C. Klawitter is typical of the friendly and efficient personnel in Standard Oil service-supply centers throughout the Midwest.

3 IMPORTANT ADVANTAGES

Standard Oil's Lubrication Service is especially geared to serve your midwest operations.

1 **Service-supply points** are near your plant. You are assured of fast deliveries, prompt lubrication engineering service.

2 **Lubrication specialists** have been specifically trained in Standard Oil Lubrication Engineering Schools to help you obtain the maximum benefits from lubricants and fuels.

3 **Research and technical facilities** are geared to help solve your specific lubrication problems.

Fast local delivery

● Anywhere in the Midwest; a simple, local phone call will bring you any petroleum product you need—double-quick! Here's why: a service-distribution set-up—unique in the oil industry—has a Standard Oil office and warehouse located practically in your own backyard! Adequate stocks of the lubricants and fuels required for the efficient operation of your plant are warehoused at that service-supply center. You can always get the product you need—*when* you need it—delivered right to your door.

Here, too, are the local headquarters for a Standard Oil lubrication specialist. He is close at hand, will give you on-the-spot engineering service. He has plenty of practical experience. He has been specially trained for his job in a Standard Oil Lubrication Engineering School. He is backed by Standard Oil's extensive research and technical facilities.

Let this lubrication specialist and Standard Oil's efficient supply service help you make real savings. Phone your local Standard Oil (Indiana) service-supply center* today.

Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

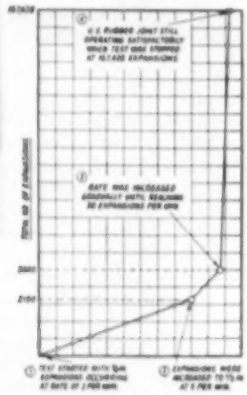
***Service-supply centers are located throughout: Colorado, Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Montana, Missouri, Nebraska, North Dakota, South Dakota, Oklahoma, Wisconsin, Wyoming.**

STANDARD OIL COMPANY (INDIANA) STANDARD

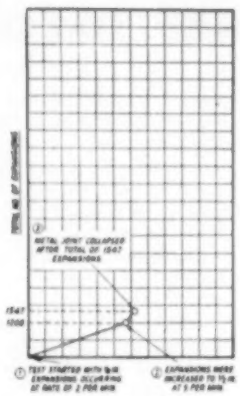
21 YEARS ON THE JOB

—and still in the pink!

Another U. S. Rubber Expansion Joint Success Story



Test of U. S. Rubber Expansion Joint



Test of Metal Joint

To determine comparative endurance, a U. S. Rubber Expansion Joint and a metal joint were subjected to the vibration tests described in the above charts. The metal joint collapsed after 1,547 cycles while the rubber joint was still operating satisfactorily after 167,428 cycles. A rigorous test for shock also demonstrated the superiority of the U. S. Rubber Expansion Joint.

An iron pipe line required replacement after 21 years of carrying a chemical refrigeration material. The "U. S." Expansion Joint photographed above was used as a flexible connection on this pipe line. When removed during dismantling of the line, the joint was found to be in sound condition — in fact it had outlasted the pipe!

United States Rubber engineers can design and build joints to meet conditions involving water, brine, oils, gases, acids and other chemicals. They can make practical recommendations for their use to take care of expansion, contraction, vibration and elimination of noise transmission and provide resistance to fire. Note the graphs at left, which show how "U. S." Expansion Joints behaved in a vibration test.

"U. S." engineers will gladly discuss and make recommendations for the solution of any problems you may have. Write to address below.

A PRODUCT OF

U.S.RUBBER
SERVING THROUGH SCIENCE

UNITED STATES RUBBER COMPANY

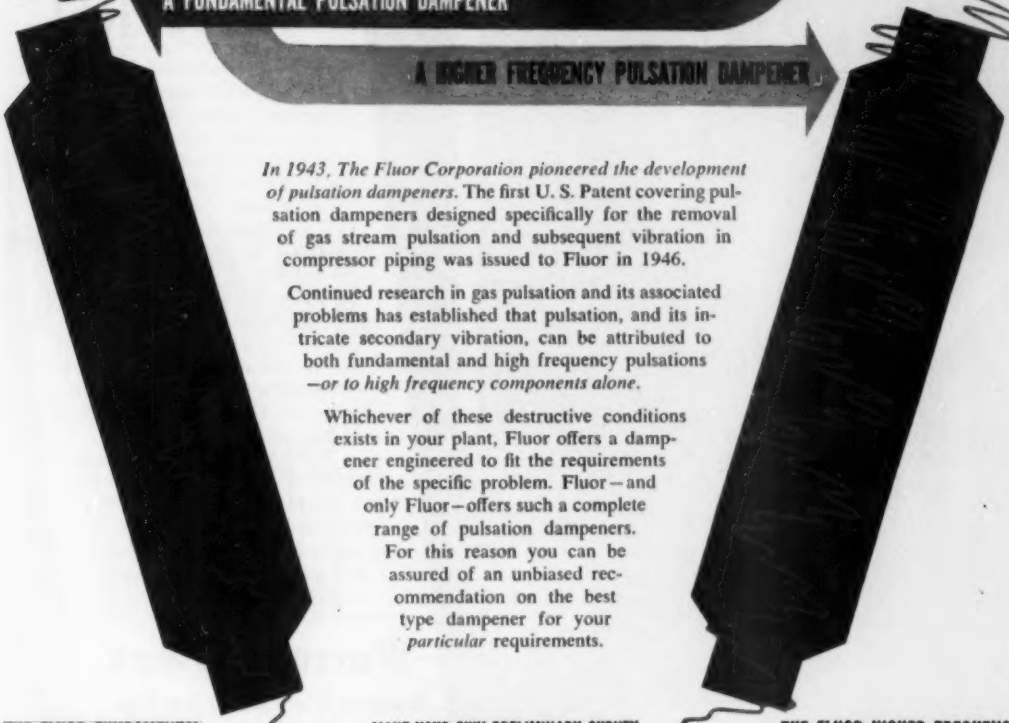
MECHANICAL GOODS DIVISION • ROCKEFELLER CENTER, NEW YORK 20, N. Y.

only FLUOR offers this selection

A CHOICE OF TWO PULSATION DAMPENERS TO SOLVE YOUR PARTICULAR PROBLEM!

A FUNDAMENTAL PULSATION DAMPENER

A HIGHER FREQUENCY PULSATION DAMPENER



In 1943, The Fluor Corporation pioneered the development of pulsation dampeners. The first U. S. Patent covering pulsation dampeners designed specifically for the removal of gas stream pulsation and subsequent vibration in compressor piping was issued to Fluor in 1946.

Continued research in gas pulsation and its associated problems has established that pulsation, and its intricate secondary vibration, can be attributed to both fundamental and high frequency pulsations *—or to high frequency components alone.*

Whichever of these destructive conditions exists in your plant, Fluor offers a dampener engineered to fit the requirements of the specific problem. Fluor—and only Fluor—offers such a complete range of pulsation dampeners. For this reason you can be assured of an unbiased recommendation on the best type dampener for your *particular* requirements.

THE FLUOR FUNDAMENTAL PULSATION DAMPENER

This type dampener smooths out all pulsations in the gas stream to the extent of at least 85%. All harmonics originally set up in each pulse cycle are automatically reduced or eliminated. This dampener is the guaranteed answer in plants where structural vibration and metering difficulties are encountered—irrespective of pulsation frequency.

MAKE YOUR OWN PRELIMINARY SURVEY

In many cases you can make your own preliminary survey to determine roughly if your pipe vibration is caused by pulsations. Write The Fluor Corporation, Ltd., Los Angeles 22, California, indicating layout of compressor house piping and operating pressures. A procedure will be mailed to you promptly. No obligation.

THE FLUOR HIGHER FREQUENCY PULSATION DAMPENER

This dampener removes objectionable pulsation frequencies encountered above the fundamental. In many instances, it has been found that metering difficulties and vibration of compressor piping and nearby vessels have been caused by the higher frequency components alone. Available in both manifold and in-line types, this dampener is competitive in cost with muffler or snubber type devices.

FLUOR

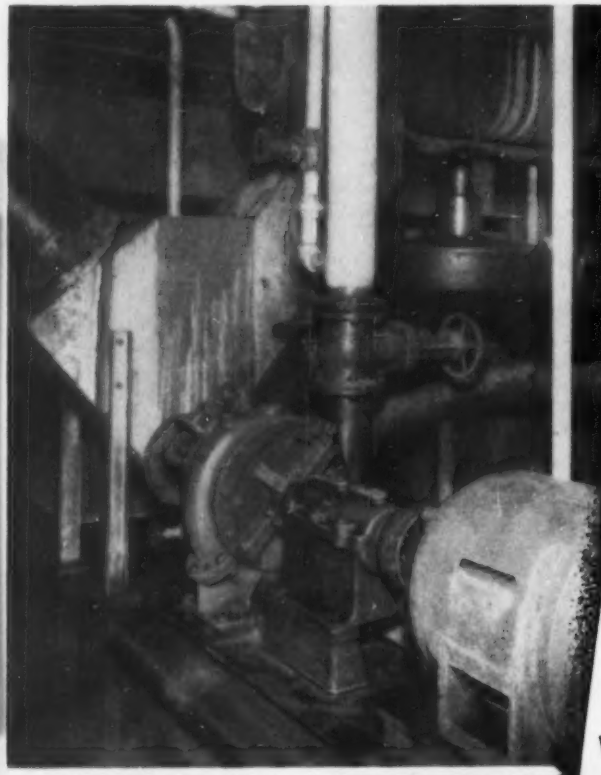
BE SURE WITH FLUOR — ENGINEERS • CONSTRUCTORS • MANUFACTURERS

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif. Offices in principal cities in the United States
REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.I., England

Hi Neighbor! Power Plant or Process—

There's a WARREN PUMP

engineered to your job!



For instance, Narragansett Brewing Company, New England's largest brewery, had a problem in the handling of spent grain which was solved by the installation of special Warren Pumps. These pumps were engineered and built for pumping pulpy materials of various densities and having properties which render them unsuitable for handling with most types of pumps.

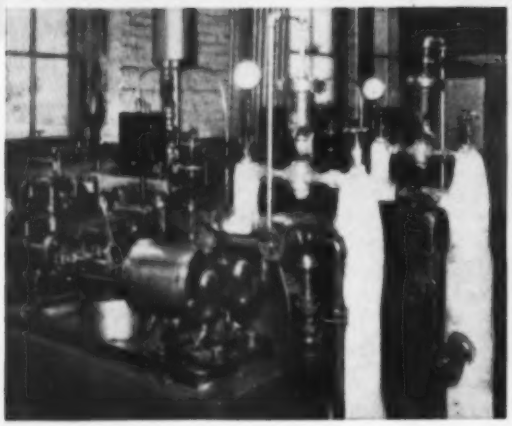
In the power plant at Narragansett, Warren Pumps are also on the job, including both steam and centrifugal and on Fuel Oil Service, Condensate, General Water Supply, etc., etc.

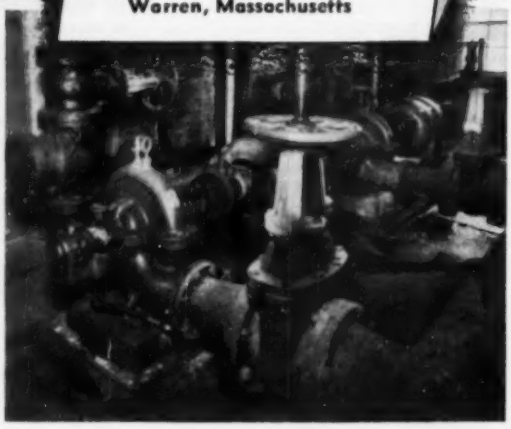
Perhaps you have a pumping problem, too . . . one that cannot be best solved by an "off-the-shelf", conventional type of pump. If so, calling in a Warren Pump Specialist may result in the right answer . . . and substantial savings in production costs. P24

Warren Pumps

Warren Steam Pump Co.

Warren, Massachusetts





DEFENSE against bacterial warfare

Every water usage point in an industrial plant presents its own particular group of problems, and at certain points—particularly cooling systems—one of the major problems is created by bacteria.

"Aerobacter aerogenes" may produce slime, impairing heat transfer in condensers and coolers. In well water systems, "Desulfovibrio desulfuricans" may cause the formation of hydrogen sulfide, thus greatly increasing corrosion. "Gallionella," an iron-fixing organism, may plug up pipe lines, reducing the capacity of equipment or putting it out of service.

Bacteriologists of Hall Laboratories have had long experience in water problems arising from bacteria and other organisms. With their cooperation, Hall engineers develop and apply the procedures which best meet each specific situation.

Bacteria and other micro-biological growths may not cause you concern, but if you have any problem in the industrial use of water you will be interested in the new Hall bulletin, "Your Most Important Raw Material." May we send you a copy?

Hall Laboratories, Inc., Hagan Building, Pittsburgh 30, Pa.

HALL *plant-wide* WATER SERVICE

BOILER WATER CONDITIONING

PROCUREMENT, TREATMENT, USAGE AND DISPOSAL OF INDUSTRIAL WATER

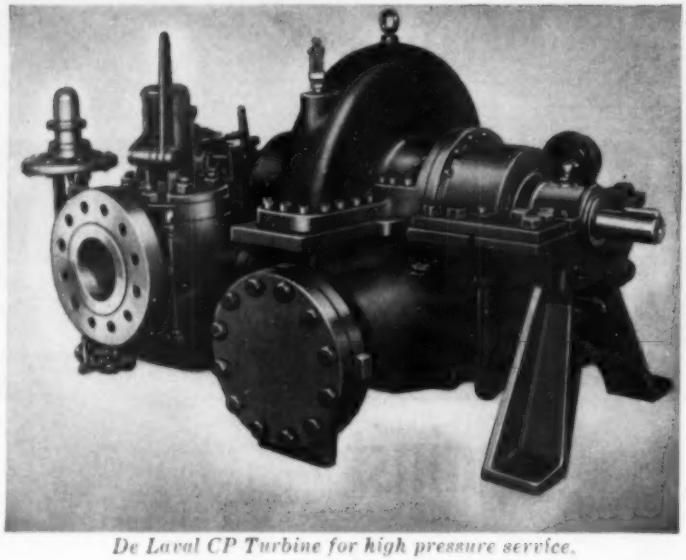
A NEW SINGLE-STAGE TURBINE DESIGNED ESPECIALLY FOR HIGH PRESSURES...

Initial pressures to 1450 psig .. Back pressures to 300 psig

THE FIRST SINGLE-STAGE TURBINE WITH ALL-LABYRINTH SHAFT SEALING

This new, high pressure single-stage turbine is more than an ordinary single-stage turbine in a "beefed up" high pressure casing. It is the *first* single-stage, mechanical drive turbine with all labyrinth shaft seals of the type generally used in large, multi-stage turbines especially designed for high pressure service.

Steam leakage along the shaft is effectively prevented by a labyrinth seal consisting of a series of shaft grooves and mating tongues of stainless steel—as many as 52 labyrinths per side being employed for the highest pressures. The labyrinth seal reduces losses, lasts longer and require less maintenance than carbon rings subject to wear.



De Laval CP Turbine for high pressure service.

When you buy a De Laval CP Turbine you also get...

True center-line support—to provide for thermal expansion without disturbing shaft alignment.

Choice of eight governing systems—to meet every control requirement.

Independent, positive over-speed trip entirely independent of the governing system for positive protection.

Horizontally split casing with steam chest in bottom half. The cover can be lifted without disturbing piping connections.

The De Laval CP Turbine is made in three sizes for capacities up to 2000 hp. For further information write for Bulletin 4215-33A-G.

DE LAVAL

DE LAVAL STEAM TURBINE COMPANY, TRENTON 2, N. J.

TURBINES • HELICAL GEARS • CENTRIFUGAL BLOWERS AND COMPRESSORS
CENTRIFUGAL PUMPS • WORM GEAR SPEED REDUCERS • IMO OIL PUMPS

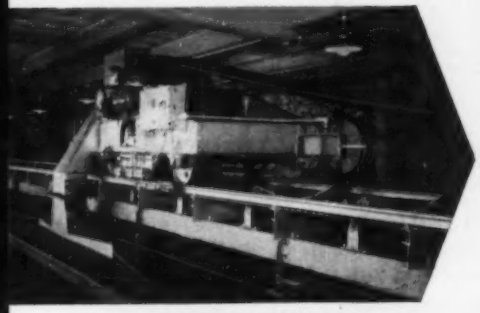
T-33A

1 then 2 and now 3

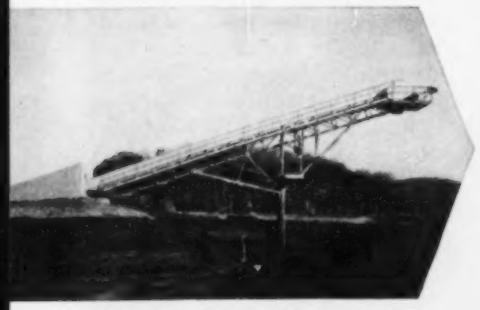
Indianapolis Power & Light Company Repeats Again with LINK-BELT Coal-Handling Equipment for Third Station

(WHITE RIVER GENERATING STATION)

The 36" wide belt conveyor in the gallery for delivering the coal to the bunkers.



View of the coal conveyor over the bunkers showing a close-up of the Link-Belt motor-driven tripper that controls the distribution of the coal; also the plow on the discharge chute for opening and closing the bin seals that confines the dust to the bins.



The yard-storage belt conveyor delivers the coal from the reversible belt conveyor below the hopper-car track to the yard.

Link-Belt equipment and engineering with Link-Belt coal-handling "know how" worked out so well for Indianapolis Power & Light Company at two other stations, that when it came to equipping the newest station, it was Link-Belt again.

Coal arrives at this station in hopper cars from which it is discharged through a reciprocating feeder to the reversible belt conveyor under the hopper track. At one end is a conveyor that delivers the coal to the storage yard; at the other end is the conveyor that terminates at the crusher house, where it is screened and tramp iron removed by a magnetic pulley. It then goes to a belt conveyor that extends over the bunkers. The distribution to the bunkers is handled by a Link-Belt motor-driven tripper. The tripper chute is equipped with a plow that opens and closes the bin seals so that the dust is confined to the bins.

The handling capacity of this Link-Belt installation is 400 tons an hour.

Every Link-Belt coal-handling installation is an example of efficiency and economy engineered to meet particular conditions. If you have a coal-handling problem, either in a public utility or industrial power plant, Link-Belt "know how" will be a big help in finding the way out. Ask our nearest office.

LINK-BELT

COAL and ASHES HANDLING EQUIPMENT

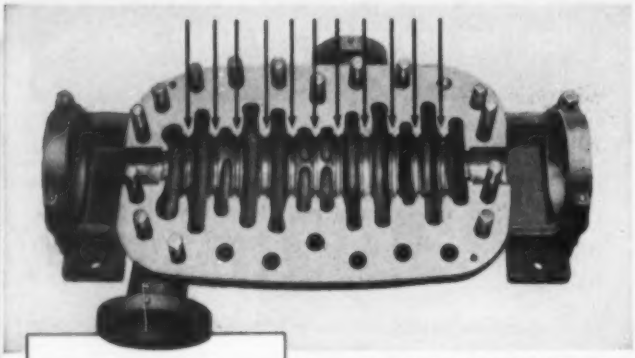
LINK-BELT COMPANY

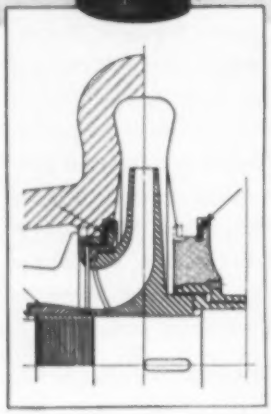
Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

LB

IN YOUR BOILER FEED PUMPING...

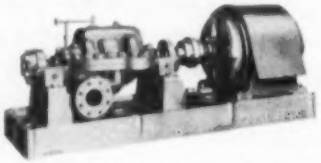
Get **HIGH** *reliability at* **MEDIUM** *pressure with* **LOW** *maintenance cost*





Lower casing half of a Worthington 6-Stage Type UR Centrifugal Volute Pump. Arrows point to joints protected by Worthington Elastic Seal Rings.

Worthington Elastic Seal Ring construction (solid black areas) in a Type UX Pump. Flexible and resilient, the Elastic Seal Ring assures initial seating, makes joints liquid-tight, eliminates a common cause of pressure loss.



This Worthington Type UQ Pump incorporates the Worthington Elastic Seal Ring, latest improvement in mechanical design.

WORTHINGTON

WORTHINGTON PUMPS, TYPES UQ AND UR, ARE TOP PERFORMERS AT PRESSURES UP TO 950 PSI

In power plants throughout the world Worthington Centrifugal Pumps, Types UQ and UR, have proved themselves the most modern small-capacity boiler feed pumps in the medium pressure range. Correct in every mechanical and hydraulic detail, they feature:

- **Balanced design . . .**
- **No stuffing box trouble . . .**
- **Freedom from interstage leakage . . .**
- **Low Maintenance Cost**

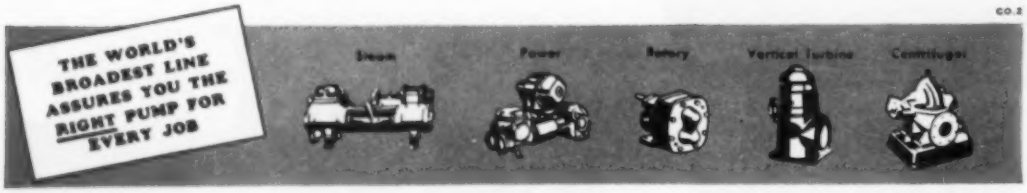
Built for long, trouble-free service, these multi-stage volute-type pumps are by far the most dependable and economical for your boiler feed jobs at pressures up to 950 psi.

There's A Worthington Pump For *Every* Pressure Range

from 100 psi to 2400 psi and all outstanding in their class. In this most complete line you're sure to find exactly the right pumps for your own boiler feed requirements, large or small. For further proof that *there's more worth in Worthington*, contact our nearest District Office or write to *Worthington Pump and Machinery Corporation, Centrifugal Pump Division, Harrison, N. J.*

CO.2

THE WORLD'S BROADEST LINE ASSURES YOU THE RIGHT PUMP FOR EVERY JOB



AT PHILIP SPORN PLANT*:

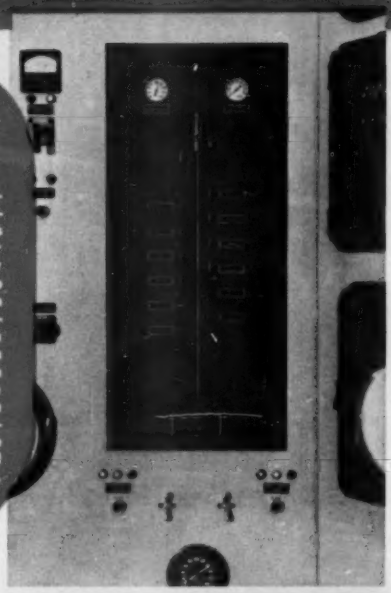
DIAMOND AUTOMATIC SEQUENTIAL SOOT BLOWING SYSTEM provides correct cleaning at minimum cost

The "human element" is eliminated from boiler cleaning by the Diamond Automatic Sequential Soot Blowing System. All blowers operate in proper sequence and at correct blowing speed every time . . . no blower can be overlooked or incorrectly operated by a careless operator. In addition to improved cleaning, there is a saving in labor as an attendant is not required by automatic operation.

At Philip Sporn Plant, Diamond Soot Blowers of various types are used according to furnace location and service required. All blowers are controlled by the control panel shown at the right. To do the complete blowing job the control room operator merely moves a lever. The control panel takes over . . . operates each blower or group of blowers correctly and in turn. On completion of the blowing cycle the panel automatically shuts off. For further information on the many advantages of Diamond Automatic Sequential Soot Blowing Systems, ask for Catalog 1014.

DIAMOND AUTOMATIC SEQUENTIAL AIR CONTROL PANEL

Controls automatic cleaning cycle of any arrangement of the various types of blowers. Operator starts cycle simply by moving start and stop valve carrier to the down position. Traveling upward, it operates each selected unit or group in turn and shuts off when all cleaning cycles are completed. Shows at a glance the unit in operation and those that have operated. No electrical connections of any kind.



*Part of the American Gas and Electric Company System.

DIAMOND POWER SPECIALTY CORP.
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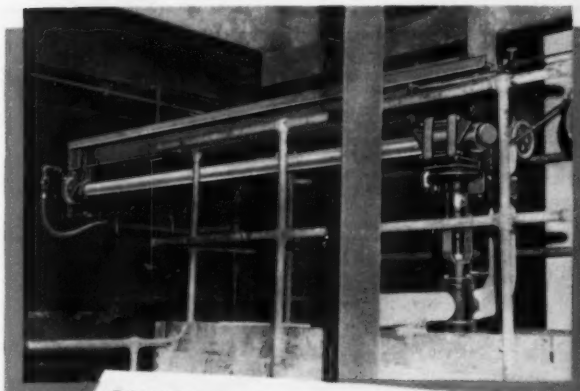
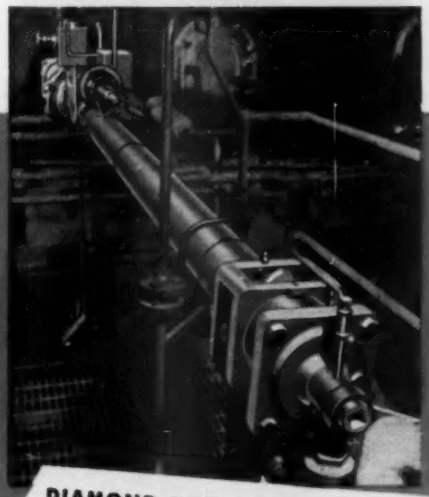


DIAMOND MODEL IK LONG RETRACTING SOOT BLOWERS



DIAMOND TELESCOPIC LONG RETRACTING SOOT BLOWERS

USE THESE BETTER

Vogt Products

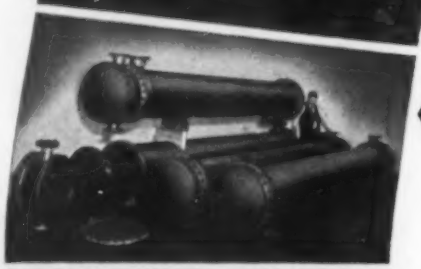
For Today's Tough Service Demands

EFFICIENT AND DEPENDABLE STEAM GENERATION

Vogt steam generating units are designed to give maximum rating in a minimum of space with high efficiency and low maintenance expense. Bent tube types and straight tube, forged steel sectional header types to burn solid, liquid or gaseous fuels, as desired, meet every power, heating or process requirement.

PROCESS EQUIPMENT FOR EVERY SERVICE

Stills, towers, oil chilling machines, filter presses, heat exchangers, etc. are constructed to all Codes. They meet all demands for operating security and trouble-free performance and help to lower costs in important process industries around the world.



SPECIAL MATERIALS FIGHT CORROSION AND PRODUCT CONTAMINATION

Our modern shops produce a wide variety of equipment made from special metals and alloys to combat corrosion, and product contamination or discoloration. Fabrication procedures employed insure that corrosion resistant properties of welds will match that of the materials from which units are constructed.

MORE TONNAGE AT LESS COST

Over 60 years of manufacturing experience, engineering and research stand behind Vogt refrigerating and ice making machinery. Absorption Systems, Compression Systems, and the Automatic Tube-Ice Machine in a wide range of capacities serve in leading petroleum refineries, chemical plants, ice and cold storage plants, dairies, packing plants, etc., at home and abroad.

DROP FORGED FOR EXTRA TOUGHNESS AND LONG-TIME SERVICE

Vogt valves, fittings and flanges, for top performance in oil, water, air, gas, and ammonia services, at high or low pressures and temperatures, are available drop forged entirely from carbon steel or stainless steel. Valves can be furnished in a combination of materials by using stainless steel for parts affected by service temperature or corrosion, and less expensive alloys or carbon steel for other parts.

Air View of Vogt Plant

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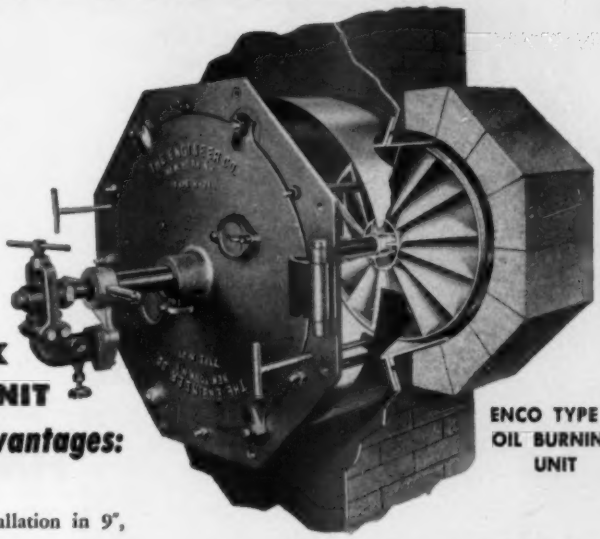
NOW! uniform combustion efficiency from high peaks to low loads with the

ENCO TYPE K

OIL·GAS BURNER UNIT

HERE'S THE LATEST advance in burner units, designed to provide completely uniform combustion over the entire load range. The new ENCO Type K Oil-Gas Burner Unit is especially effective where steam demands swing sharply over short periods.

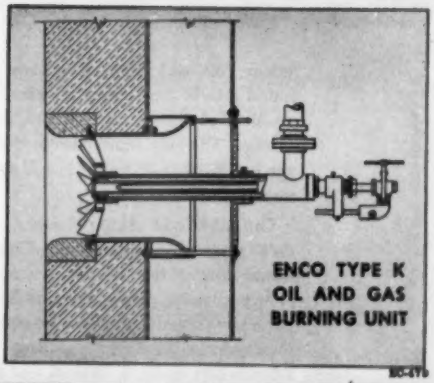


ENCO TYPE K OIL BURNING UNIT

THE ENCO TYPE K OIL·GAS BURNER UNIT *Offers These Additional Advantages:*

1 Natural or forced draft operation.
2 Register draft tube designed for installation in 9", 13½", 18" and 22½" furnace walls.
3 No movable blades.
4 Air vanes provide fixed turbulence over entire load range. Adjustable for long or short flame.
5 Air volume control damper.
6 Hinged door for easy access to internal parts for inspection or removal.
7 Suitable for either steam or mechanical atomizing type oil atomizers.
8 Gas burner gun can be added for combination of gas and/or oil.
9 Comes in a wide range of sizes and capacities.

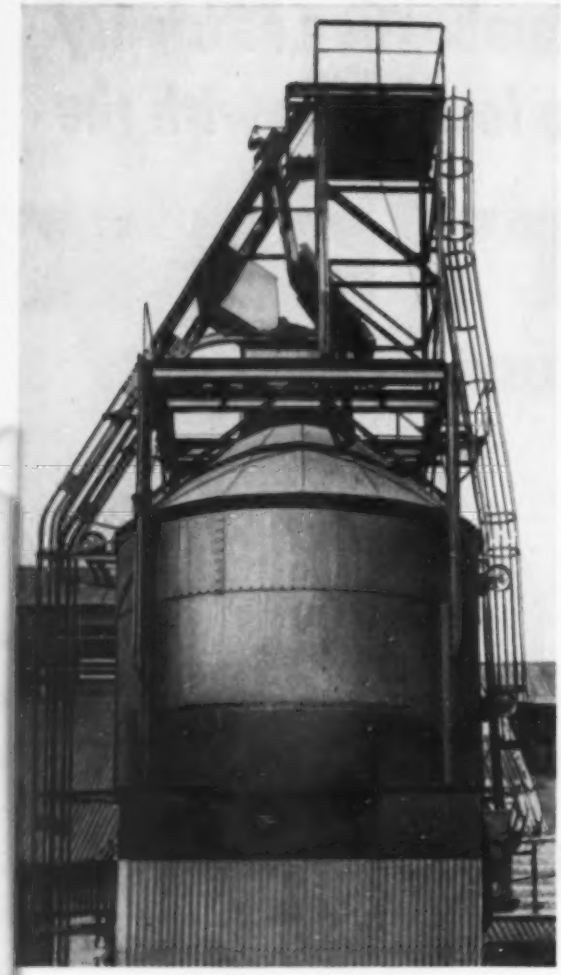
This new Type K Unit is the result of pioneering research, aimed to help you achieve more efficient, more economical boiler operation. Write today for further information, or see your local Enco Representative.



ENCO TYPE K OIL AND GAS BURNING UNIT

BS-LYL

THE ENGINEER COMPANY



LOW COST DEPENDABLE COAL HANDLING FOR PUBLIC UTILITIES

Salem Gas and Light Company, Salem, Mass., found a G-W Skip Hoist the ideal solution to the problem of conveying coal and coke to producer storage. The skip bucket keeps the producer-storage bin filled at all times . . . and does the job with maximum economy.

Gifford-Wood Skip Hoists . . . one of many G-W systems of materials handling . . . are low in initial cost . . . low in maintenance . . . long-lived . . . completely dependable. Public utility companies the country over are becoming increasingly interested in Skip Hoist handling of coke, coal and ashes where space is limited and both initial and operating costs must be kept at rock bottom.

This particular installation may not be the perfect solution to your own particular problem. Gifford-Wood, however, has specialized in the design, engineering and installation of all types of materials handling systems for 136 years. To have a Gifford-Wood Materials Handling Engineer survey your present method of moving materials, places you under no obligation and it may well be your first step toward lower operating costs and increased production.

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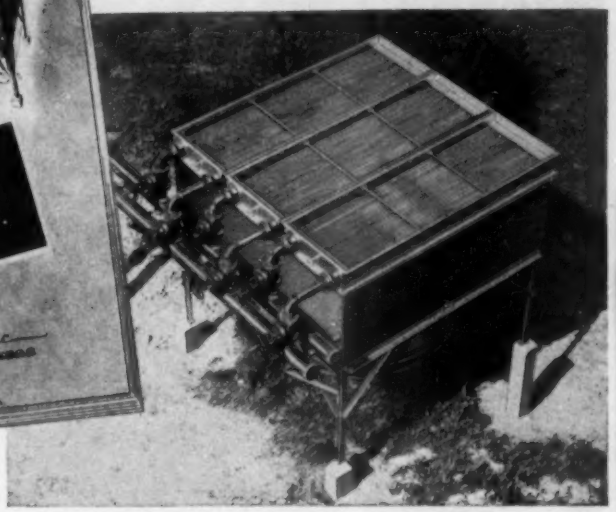

on dry cooling equipment... DriCooler®

Whether you have an engine in a power plant — products to cool or condense in a natural gasoline plant — engines or gas to cool at a gas pipeline compressor station — high level heat dissipation in a refinery or a small standby engine to cool .... Marley has a DRICOOLER to do your job!

Small "packaged" DRICOOLERS or large industrial units are all built to give years of dependable service. All DRICOOLERS, large or small, have finned tubes that are easy to clean, quick to drain and have been tested for long life. Proven Marley mechanical equipment insures smooth, quiet operation.

DRICOOLERS are standard in forced or induced draft, horizontal or vertical coils, steel units or abestos-board covered redwood structures, and sections are available with various fin and tube materials and header arrangements.

WRITE FOR THE NEW DRICOOLER BULLETIN

- Gives rating tables for cooling water
- Lists dimensions and weights
- Shows coils, structure and mechanical equipment
- Photographs of actual installations

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Please send me without obligation Bulletin DC-50 on the complete line of Marley DRICOOLERS.

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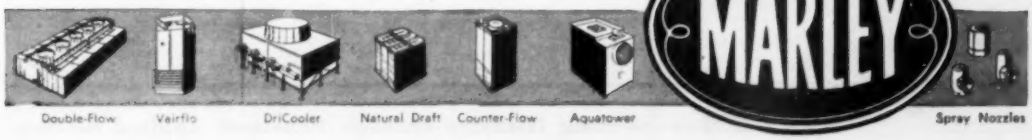
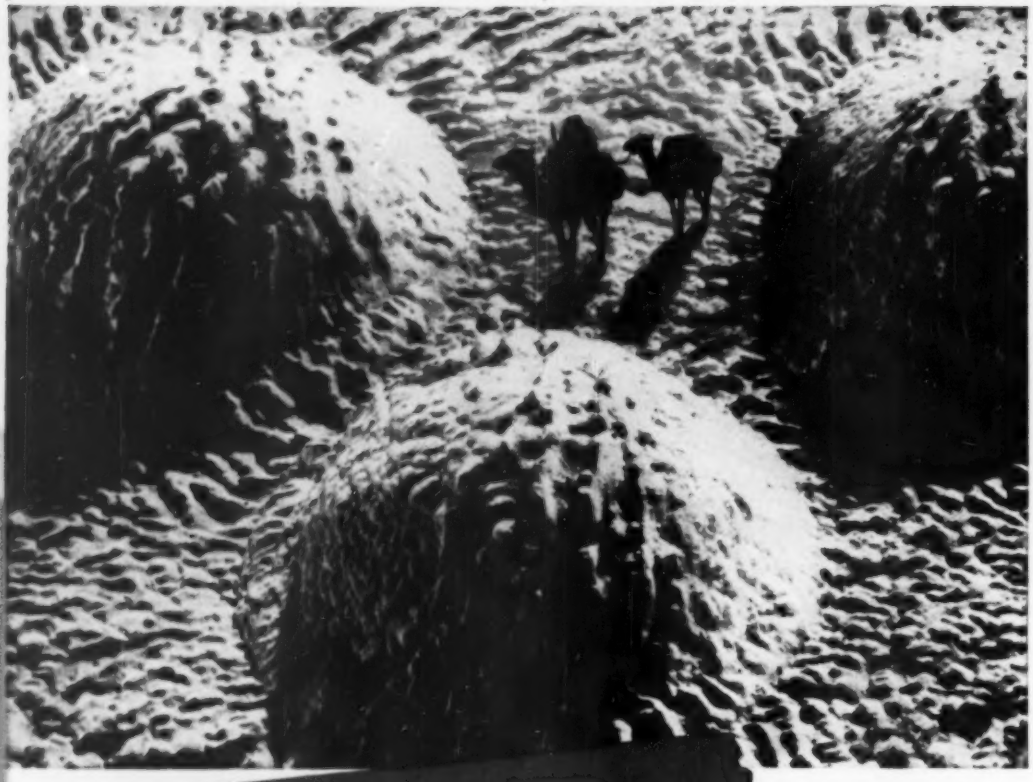
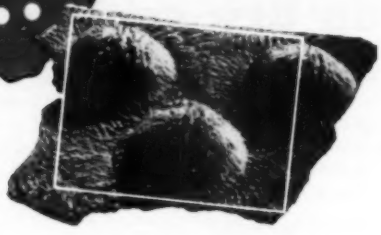




Desert Waste...

THIS "desert" was formed under water—improperly treated boiler water. It represents needless waste in several ways . . . Boiler down time . . . Overheated drum and rivet metal . . . Loss of heat transfer efficiency . . . Sluggish response to load changes.

Since the scale was removed, The Nalco System has kept the boiler clean-to-metal and corrosion-free continuously—and economically. Where conditions require uninterrupted boiler operation, The Nalco System can also be utilized to remove old scale, as well as prevent new deposits. Either way, The Nalco System is your assurance of *permanent water treatment results.* Write for prompt action on your problems.



Rectangle in small photo shows area of scale sample in large illustration. "Hills" are scale-covered rivet heads. Approximate size of sample: 7" x 5". *Nalco Laboratory photo.*

NATIONAL ALUMINATE CORPORATION
6224 West 66th Place
Chicago 38, Illinois

Canadian inquiries should be addressed to Alchem Limited, Burlington, Ontario

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HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail

PUMPS, TURBINES

101 **For Many Pumping Jobs**—The Series A313A, latest of company's well-known IMO pumps and especially designed for low cost standardized, quantity production, is described in illustrated Bulletin L313A-B, 8 pp. This is a general service screw-type rotary pump for petroleum products and other light or viscous fluids as required for rotary and steam atomizing oil burners, oil transfer, lubrication, hydraulic systems and similar services. Bulletins contain a cross-section drawing, description of the IMO pumping principle, viscosity tables and motor frame sizes. De Laval Steam Turbine Co.

102 **Hydraulic Turbines and Auxiliaries**—Bulletin 02B7301, 56 pp, describes and illustrates the design and construction of Francis, propeller and impulse type hydraulic turbines and such auxiliaries as pressure regulators, special high head valves, butterfly valves and cabinet type governors for large units. More than 30 installations in the United States and other countries are covered, including Hoover Dam, the Collmilla plant in Mexico, Kentucky Dam, the Serra powerhouse in Brazil and Honokaa Sugar Co. in Hawaii. Allis-Chalmers Mfg. Co.

103 **Multi-Stage Turbine**—Twelve-pp Bulletin S-146 features design details of company's multi-stage turbines. Illustrated with photos and drawings, it gives data on casings, lagging, blades, nozzles, wheels, shafts, diaphragms, bearings, interstage and end glands, governors, synchronizers, governor valves, steam strainers, nozzle control valves, auxiliary oil pump and lubrication. The Terry Steam Turbine Co.

104 **Cradle Mounted Centrifugal Pumps**—The construction features of centrifugal pumps in 20 to 550 gpm capacities and designed for process and refinery service are described and illustrated in Form 7212. Includes dimensions, specifications. Cameron Pump Div., Ingersoll-Rand Co.

105 **Automatic Pumping for Elevated Tanks**—Bulletin 1200, 4 pp, describes company's Autocon Mototrols, pressure operated pump controls with twin bellows for elevated tank systems, and tells how they afford better liquid level control. Shows how motors work to provide accurate control and discusses their flexibility, protection provided, and easy installation and adjustment. Sequence of operation is illustrated and explained, specifications given. Automatic Control Co.

TUBES, TUBING

106 **Tubing Handbook**—Titled, "So You Want to Use Tubing," 60-pp Catalog 50 pertains to the bending, warehousing and fabricating of pipe and tubing. Generously illustrated with photos and how-to-do sketches, it contains a wealth of information on the handling of pipe and the machines and tools designed to do it. Also describes and illustrates company's bending machines, both hand and power operated, saws, shears and cutters and other tools, as well as pipe and tubing. Wallace Supplies Mfg. Co.

107 **Seamless, Welded Tubes**—Six-pp Bulletin TB-329 on heat exchanger and condenser tubes provides specifications and data on various grades and size ranges available. Also includes application information on carbon steel, low and intermediate chromium steels, nickel steels and stainless steel tubes. The Babcock & Wilcox Tube Co.

108 **Steel Tubing**—Technical data and fabricating information on steel tubing are given in this 20-pp handbook. Illustrated with photos and colored sketches, it explains merits of this double-walled tubing made from a single strip of metal and discusses some of its uses. Includes specifications, corrosion and fatigue resistance data and tells how tubing may be fabricated, coatings which may be applied. Available sizes and lengths are listed, typical fabricated parts illustrated. Bundy Tubing Co.

ELECTRICAL

109 **Electrical Connectors**—Bulletin MC-108-2, 6 pp, is an ordering catalog covering company's standard line of molded neoprene rubber electrical connectors and related equipment—lamp sockets, distribution centers and vulcanizers. All equipment is illustrated and described as to construction and application and available sizes listed. Mines Equipment Div., Joy Mfg. Co.

110 **New Booklet on Transformers**—Design and construction features of company's power and distribution transformers—both large and small and secondary network—are described in Bulletin 01B6186B, 16 pp. Also covered are three types of load-ratio-control mechanisms available on the power transformers, depending on voltage, kva capacity and other circuit conditions. Step regulators, pole-type regulators, unit substations of all types, and instrument transformers are also presented. Allis-Chalmers Mfg. Co.

111 **Polyphase Electric Motors**—Twelve-pp Bulletin EM44-812 describes 1 to 75-hp horizontal motors, illustrating their construction details in cross section and cutaway views in full color. Among features described are motor appearance, insulation, bearings, ventilation, mounting, service, frames and end bells, terminal box, rotors and machining. Motor Div., A. O. Smith Corp.

112 **Motor Reversing Switch**—This Bulletin describes the design, installation and application of the new Iron Fireman Reverswitch applicable to any standard make of split phase and capacitor start motors. Mounted in the end bell, the switch provides instant reversal, quick stop or normal starting and stopping of single phase motors. Heating Control Div., Iron Fireman Mfg. Co.

FITTINGS, VALVES

113 **Expansion Joints**—Sixteen-pp Bulletin B-35-51 explains the design and construction of company's corrugated packless expansion joint that requires no main-

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tenance. Includes sizes, temperature and pressure ratings, dimensions and weights. Simplified selection charts make it easy to determine proper joint for most applications. Recommended installation practice is summarized with pertinent engineering information. Illustrated with photos of types, cutaway views and typical installations. American District Steam Co.

114 **Hose Couplings and Fittings**—Catalog Section 3100, 12 pp, pictures and gives details on couplings and fittings manufactured by company, together with specifications, general and maximum pressure recommendations and a description of threads. Products cataloged include common couplings; combination nipples, special suction hose couplings. Interlocking high pressure couplings; hydraulic hose couplings and hose adapter unions; pipe, inserted, built-on and seored nipples, flanges, hose clamps and hose menders. The B. F. Goodrich Co.

115 **Pipe Fittings Catalog**—Anyone who specifies cast iron and malleable pipe fittings will appreciate Catalog 50 P. Described as a model of conciseness and easy reference, this 118-pp fairbrkoid-bound book provides listings complete on each page so you won't have to refer to other pages for details. Includes photo, dimensional drawing of each fitting, along with price, weight and dimensions. There's also a condensed price list for those who want cost information only. Packing weights and essential engineering data are included. Stockham Valves & Fittings.

116 **Tube Fittings Selection Guide**—Bulletin 342A contains at-a-glance factual data on brass fittings for use with copper, aluminum, brass, steel and other metal tubing. Provides, in tabular form, assembly and cut section views, of several types, an explanation of methods of assembly, tubing for which fitting is suited, size range, applications and advantages, as well as illustrations of stock types available. Shut-off cocks, tube working tools and pipe fittings are briefly described and illustrated. The Imperial Brass Mfg. Co.

117 **Solenoid Valves**—Company's expanded line of direct operated solenoid valves for automatic or remote flow control of liquids and steam up to 400 F as well as high viscosity liquids is covered in Bulletin V. Lists sizes from ⅛ to 3 in.; valves for normally open or normally closed service; stainless steel or Jenkins disc seats; valves with special dash-pot construction to stop water hammer; 3-way solenoid valves. All valves are built for pressures to 150 lb, quick-opening and free of pilot valves or auxiliary pistons. Many typical installations are pictured. The Johnson Corp.

118 **Air for Power**—Catalog 105 illustrates 20 types and 14 sizes of air operated vibrators, valves and fittings that have a wide range of application for shaking settling materials. Explains how vibrators operate the many functions they serve. The Cleveland Vibrator Co.

119 **Unions and Valves**—Catalog 11, 20 pp, presents company's full line of steel unions—standard, heavy duty, orifice, lug nut and other types—as well as several types of check valves for vertical and horizontal use. Includes data on steels used and on union seats and coupling threads. Equipment listed is accompanied by photos, sizes, thread ranges, pressures handled, also prices. Includes table of dimensions and weights of steel pipe. Catawissa Valve and Fittings Co.

REFRACTORIES, MORTAR

120 **Refractory Jointing Material**—Four-pp Bulletin 101A is filled with helpful information on company's refractory material with high resistance to molten metal and slag for use as metal-tight linings. Discusses properties of the material and its use in hot metal mixers, transfer cars, ladles, pipe welding furnaces and like applications. Also tells how to prepare and mix it. Includes table showing properties and uses of company's other cement and plastic specialties. Laclede-Christy Co.

121 **Refractory Hanger Wall**—A light, tight, wall with low heat loss is described in this 4-pp folder, illustrated in color. Discusses advantages of the wall, illustrates hanger and face tile types and shows how hanger wall is installed M. H. Detrick Co.

122 **Bonding Mortar**—Four-pp Bulletin D-117A explains the composition, properties and applications of a chrome bonding cement intended to prolong the life of industrial furnace linings. Also discusses packaging of the mortar, its preparation for use, and how to estimate quantities required. E. J. Lavino and Co.

VENTILATING, DEHUMIDIFYING, DUST REMOVAL

123 **Industrial Ventilating Fans**—This informative catalog is comprised of engineering data sheets on company's Series 16 direct-drive industrial ventilating fans in 3 to 5 ft dia, with capacities from 11,000 to 30,000 cfm. Provides details on fans' construction, performance, installation and maintenance, also gives prices. Also contains information on ventilating fan applications and the planning of ventilating systems. This book is especially of value to engineers whose plants present problems caused by lint or dust laden air. The Moore Co.

124 **Because Moisture Isn't Pink**—Under this title, 30-pp Bulletin 216 explains that while high humidity doesn't show it can and does spoil many a product in process and storage. Tells how typical plants solved the excess moisture problem by installation of company's electric dehumidifiers. Describes and illustrates their installation in a variety of applications. Pittsburgh Lectrodryer Corp.

125 **Dust Collecting Efficiency**—How the higher and narrower inlet utilized in company's tubular dust collector contributes to more efficient dust collecting is explained in this illustrated bulletin. Cutaway drawings showing tube design and micron efficiency curves accompany the text. Prat-Daniel Corp.

126 **Gas Scrubbers**—Performance data on company's Pease-Anthony gas scrubbers of both the cyclonic and venturi types for the removal of both micron-sized dusts and sub-micron dusts, fumes and mists, is presented in Chemico Bulletin M-102, 8 pp. Describes both types of scrubbers, giving advantages, illustrating typical installations. Chemical Construction Corp., Unit, American Cyanamid Co.

INSTRUMENTS

127 **Metering Flow Tube**—Engineering data on company's new primary element for high-accuracy measurement, regulation and control of fluid flow is given in 4-pp Catalog 80. Includes formulas showing theory of operation and capacity curves covering its use for high main line velocities, medium to low main line velocities, and for steam condensate vapors. Foster Engineering Co.

128 **Recording Thermometers**—Bulletin T940 is a 44-pp fact-filled catalog on company's "Series 500" line of thermometers. Liquid-filled, vapor pressure, and gas-filled types are described in models for recording, indicating, controlling, and telemetering of temperatures. Each is fully described along with information on operat-

(Continued on page 111)

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CHEMISTRY APPLIED TO MAINTENANCE CLEANING PROBLEMS

Mill "M" asked: "How fast can you clean a boiler?"

Dowell Service cleaned the internal surfaces in 10 hours!

This was the case of a boiler generating 350,000 pounds of steam per hour with an operating pressure of 1250 p.s.i. In ten hours Dowell Service removed an estimated 1,000 lbs. of deposits which were causing tube failures. The boiler was back on the line the next day.

What is Dowell Service? It is simply the application of chemistry to the problem of removing deposits from heat exchangers, water lines and all kinds of process equipment. Dowell engineers fill the equipment with liquid solvents which reach wherever steam and water flow and are designed to dissolve and disintegrate the deposits efficiently and quickly. Dismantling is not necessary.

Somewhere in your plant there is a job that can be done *faster, better, more economically* by Dowell Service. Let an experienced Dowell Service Engineer help you with your maintenance planning. No obligation, of course.

Other recent Dowell jobs:

Entire Piping Systems of two college dormitories cleaned of scale.

•

Three Formaldehyde Contact Towers and Reboilers cleaned and restored to designed operating efficiency.

•

Six Black Liquor Evaporators cleaned for paper company. Deposits removed from vapor and liquor sides in one operation.

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DOWELL INCORPORATED · TULSA 3, OKLAHOMA

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

New York 20	Buffalo 2	Kansas City 8	Mt. Pleasant, Mich.
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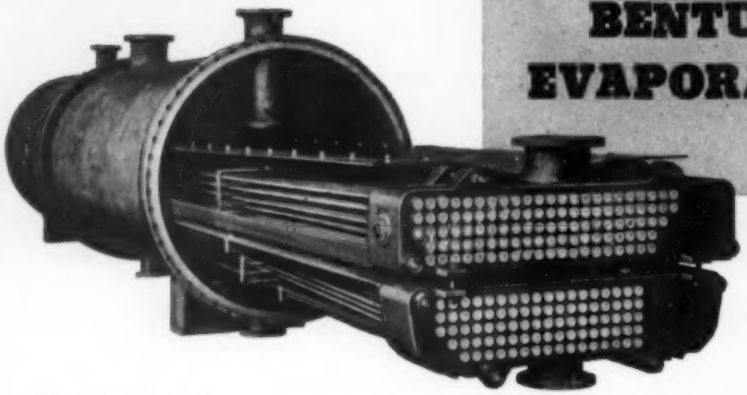
DOWELL

PUREST Make-Up Water

from the ..... **G-R BENTUBE EVAPORATOR**



NO MATTER what the kind or amount of impurities in your feedwater supply, you can count on getting pure distilled boiler feed make-up from a G-R Bentube Evaporator. This make-up water is, in fact, *purer than that obtainable by any other method.* Its hardness is as low as one part per million. Silica content can be reduced to one-tenth part per million.

You can be sure, too, that a G-R Bentube Evaporator will maintain rated capacity throughout its long life. That's because of the patented design of the G-R Bentube elements, which are set with a slight initial curvature into the cast headers. *This exclusive scale-shedding design completely eliminates hand scaling.* Variations in temperature cause changes in the curvature of the tubes, thereby shedding the scale from the tube surface at regular cracking periods and during normal operation.

In addition, the G-R Bentube Evaporator offers distinctive features that assure 100% effective evaporating surface, pure dry vapor, minimum pressure drop of steam through the evaporator, free dropping of scale to the bottom of the shell and convenient access to the shell interior.

BULLETIN 366 *fully describes the wide-range line of* G-R BENTUBE EVAPORATORS. *Write for your copy today.*

THE GRISCOM-RUSSELL CO. • 285 MADISON AVE., NEW YORK 17, N. Y.

GRISCOM-RUSSELL

PIONEERS IN HEAT TRANSFER APPARATUS

COMPLETELY DEIONIZED WATER IN ONE PASS THROUGH ONE UNIT!

Get full details of the technique that's revolutionizing water treating.

Once through a *single* bed of AMBERLITE ion exchange resins, and your water supply is rid of silica, carbon dioxide, calcium—*all* ionized solids!

AMBERLITE Monobed deionization is fast replacing multiple-bed methods of producing high quality water for boiler feed, electroplating, deposition of phosphors, washing of photographic film.

The column on the right will tell you *why*.

Consulting engineers and manufacturers of water conditioning equipment can tell you *how* Monobed deionization insures the life and efficiency of your boilers, improves your process and your product.

Our new 12-page booklet tells you *what* AMBERLITE Monobed deionization is. Write to Dept. PEI-8 for your copy—today.

AMBERLITE Monobed Deionization Offers You . . .

1. Low equipment costs
2. Low operating costs
3. Extreme ease of operation
4. Uniform performance in intermittent service
5. Controlled quality of effluent

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

Washington Square Philadelphia 5, Pa.

The Resinous Products Division was formerly The Resinous Products & Chemical Company

AMBERLITE is a trademark, Reg. U.S. Pat. Off. and in principal foreign countries.

WATER'S TOO SCARCE and COSTLY to WASTE

Save it with a C. H. W. Cooling Tower

Look how much this source of water has dried up! And this is no exception, either. More and more plants are feeling the "pinch" in water supply. Industrial expansion, plus higher domestic use, has overtaxed supply in many areas. Good surface water sources are low and, in areas where there is plenty, the quality is poor and costly to make usable. Although sufficient underground water deposits exist,* it will be several years before they can be tapped. All this means that you'll have to get the most out of what you have, or face production cuts or even a shutdown. But there is something you can do—use a C. H. W. cooling tower for operations requiring cooled water, thus permitting use of the same water over and over again. And you'll find that a C. H. W. cooling tower will not only save water and its cost, but also that cooling performance is guaranteed. For any operation requiring cooled water—chemical, processing, petroleum, air conditioning, etc.—check on a C. H. W. cooling tower first. Write for literature.

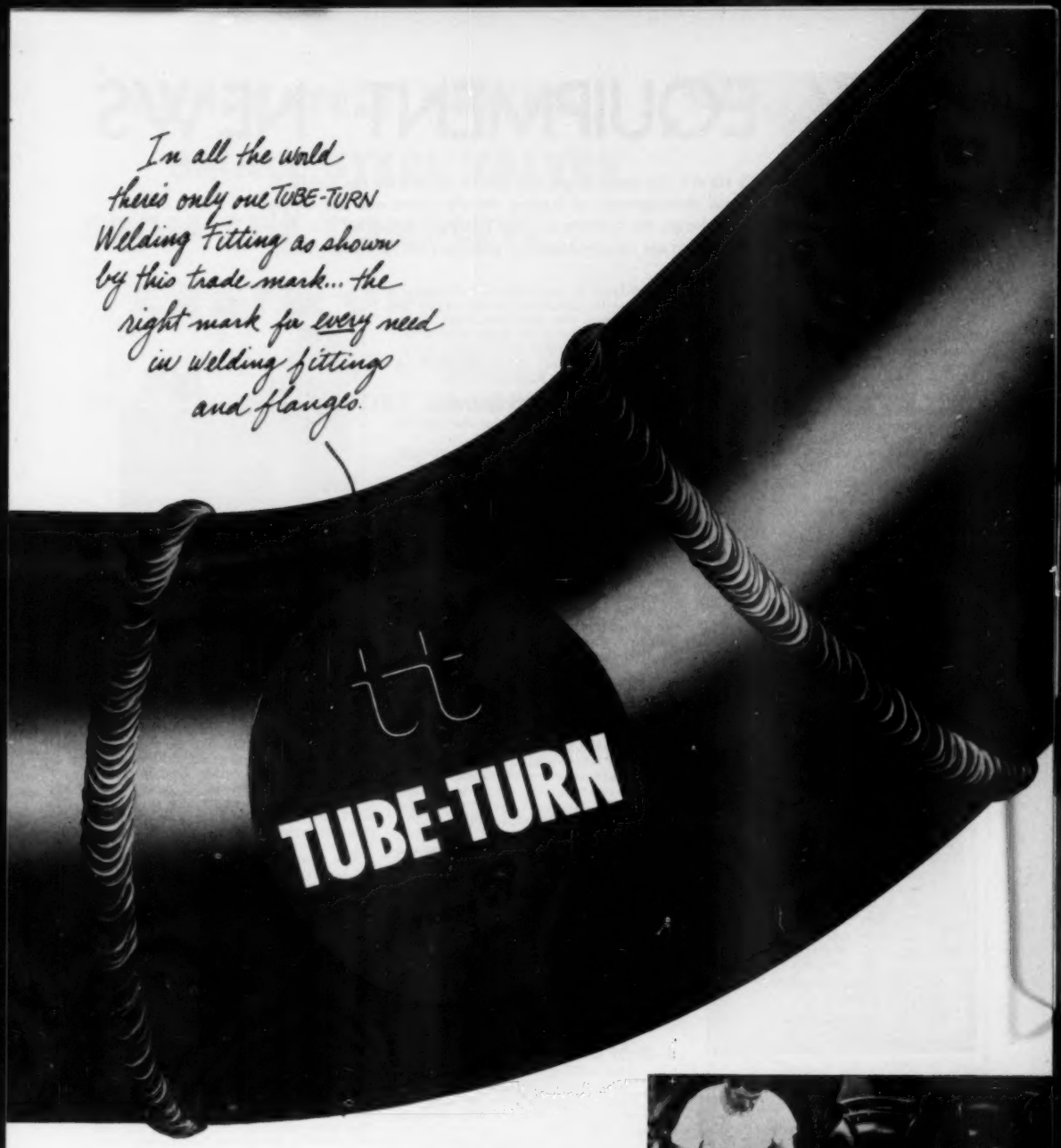
*According to Government surveys

C. H. WHEELER MANUFACTURING CO.
1803 Sedgley Ave., Philadelphia 32, Pa.
REPRESENTATIVES IN MOST PRINCIPAL CITIES

C. H. Wheeler
SINCE 1903

DECK MACHINERY · STEAM CONDENSERS
STEAM JET AIR EJECTORS
OF PHILADELPHIA

In all the world there's only one TUBE-TURN Welding Fitting as shown by this trade mark... the right mark for every need in welding fittings and flanges.



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NEW EQUIPMENT NEWS

WHAT'S NEW? On these pages the Editors summarize the outstanding industrial developments of leading manufacturers who will supply you, free of charge, the bulletins or other information desired. For ease in making requests use the no-obligation, postage-paid card pages 35-36.

1—VERTICAL TURBINE PUMPS

Water or oil lubricated, available in 50 to 15,000 gpm capacities

Manufacturer announces that these are an entirely new line of pumps designed to develop maximum performance per size, and points out that overlapping coverage permits selection of a unit for nearly any capacity and head condition.

These pumps have extra size bearings, shaft seals where required, enclosed impellers, wearing rings and flanged and bolted bowl construction. They're arranged for motor drive, right angle gear drive or belt drive and are suitable for many services, including installation in wells for water supply, installation in sumps, tanks and reservoirs, for pumping water, refinery products, other liquids. Worthington Pump and Machinery Corp.

2—CIRCULATION SYSTEM

For increasing the output of steam heated processing equipment

This circulation system was especially designed to improve the efficiency of platen presses in the plastics and rubber industry, heaters for drying machines, and tubular heaters of stills and evaporators. It works by accelerating the flow of steam and condensate in the steam spaces of platen presses and tubular heating surfaces. In this

type of surface the flow of condensate to the steam may be sluggish and result in poor efficiency for which the steam trap is not responsible.

The system consists of company's float trap and circulator. The latter is an injector which uses the uncondensed steam to induce turbulence in the condensate flow, so as to improve heat transfer and speed up production with a saving of steam. Sarco Co., Inc.

3—ENCLOSED MOTORS

In 5 to 250 hp ratings, are fan cooled and have cast iron frames

These are totally enclosed motors available in standard and explosion-proof types. They're described as especially suitable for use where corrosion is a problem—either because of the kind of materials processed or because the motors have to be installed outdoors.

Built with cast iron frame, endplates blower shield and cast aluminum rotor, these motors are given both in insulating varnish treatment and a heavy coating of a special acid and alkali resisting varnish. Wagner Electric Corp.

4—RECORDING INSTRUMENTS

Feature new case design that accommodates up to four pens

You can use these meters for a variety of temperature-pressure combinations—the case design allows the use of four pens. It also provides enough storage space for 200 charts and 4 bottles of ink, so operator can change the charts quickly without risk of applying the wrong one.

Temperature measurement by the self-actuated tube systems of the gas-filled, vapor tensions and liquid-filled types for ranges from -100 F to 800 F are offered. Company stresses that the Bourdon springs are unusually sturdy. Penn Industrial Instrument Corp.

5—SERVICE UNIT

For distribution systems, serves one load from either of two feeders

This is a 5000 v, 400 amp unit combining an air break isolation link compartment, two single throw load break oil switches and an automatic feeder transfer mechanism in one compact factory assembled unit. Only one load and two feeder connections are needed to put it in full operation.

The automatic transfer mechanism is designed to shift the load from preferred to emergency feeder, and transfer it back to the preferred when it is re-energized. The emergency source can be an alternate feeder or a diesel stand-by plant. A time delay relay may be added to control circuit to allow the stand-by plant to build up to full voltage before taking over the load. Unit can be furnished with entrances for either underground or overhead cables. G & W Electric Specialty Co.

6—SHOP ON WHEELS

Has working space, place for tools; can be rolled right to the job

The Rol-Cab saves the mechanic or maintenance man many a trip between job and tool crib. It's built of heavy gage steel, spot welded, and has a Masonite-covered reinforced solid-steel top for mounting a vise or bench grinder. Top surface is 45 by 24 in.

Storage space is provided by seven ball-bearing drawers of different sizes, two compartments for large items, and a series of 20 bins for the small parts. All drawers and compartments can be locked.

There's a large swivel light on top and an electrical supply incorporated in the cab. Two double outlets are provided for the light and for electrical tools. Cab has large roller-bearing rubber-tired wheels and independent foot brakes to hold it in place when in use. It's 36⅜ in. high, weighs 388 lb net, finished in red enamel. Snap-On Tools Corp.

7—VACUUM PUMPS

Single or duplex units, for capacities from 2500 to 20,000 EDR

The compact Model C Vacuum Pumps are space savers in the boiler room. The centrifugal pump and electric motor are mounted on the side of the vacuum pump, above floor level. And in many installations, the Model C doesn't require a separate accumulator tank. Inlet connections are at a low level, so the accumulator tank may be built into the air separating tank.

The Model C is a self-contained unit. Wiring from all controls terminates in a unified control panel on the front of the pump. C. A. Dunham Co.

8—DIAPHRAGM VALVES

In sizes from ¼ to 8 in., for controlling flow of steam, water, gases

Flowrite Valves are air- or water-operated for pressures below 250 psi. A variety of stainless steel or bronze valve bodies are available in the line—single or double seat, double unions and flanged ends, direct and reverse acting and three-way types.

Bonnet assembly incorporates a stainless steel stem in preformed lubricated metallic packing. Housing and top are cast iron. Among features stressed are the molded Neoprene diaphragm with positive sealing bead, and the piston plate assembly with free floating thrust plate to absorb side thrust. The ball bearing non-rising adjusting screw has a 180 deg turning radius with starting pressure adjustable from 0 to 17 psi and enclosed steel spring for full travel in 5 or 10 psi control pressure change. The Powers Regulator Co.

9—FIELD TEST SET

Is developed for quick checking of current transformer installations

This test set checks the transformers for short circuited turns, high resistance

MODERATELY PRICED SMALL STEEL VALVES FROM THE COMPLETE CRANE LINE

UNION BONNET GATES . . . MORE COMPACT, MORE RUGGED

Here's a valve value made possible by Crane Co.'s finer facilities for *quality* mass production. These low-cost, small steel gates are specially designed for a wide range of tough services. They readily withstand rough usage, piping and pressure strains, and extreme variations in temperature. The features below show how and why they do it.

COMPACT OVERALL DESIGN—size for size, these valves are more compact than the usual high-pressure design—at no sacrifice of strength.

TIGHT UNION BONNET JOINT—heavy steel union ring with long, precision-cut threads pulls up easily, stays tight, protects against distortion when joint is opened. Male and female bonnet joint with soft iron gasket eliminates possibility of gasket blowout.

LEAKPROOF BODY SEAT RINGS—are securely rolled into the body. No danger of leakage around ring. Cannot loosen in service.

FULLY GUIDED SOLID WEDGE DISC—cannot get out of line or jam in body. Disc drag and wear on seating surfaces are minimized.

GET DESCRIPTIVE FOLDER AD-1741 for more data on these valves. Gives sizes, dimensions, and service recommendations. Ask your Crane Representative for a copy or write direct. These valves also listed in your Crane No. 49 Catalog, P. 223.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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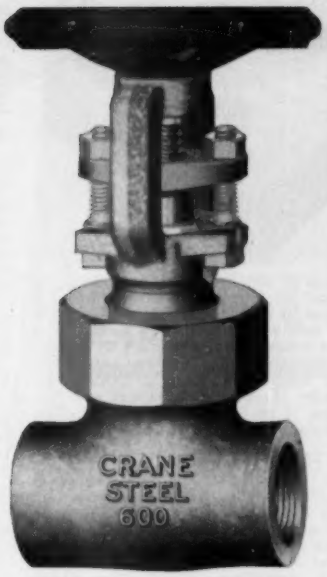
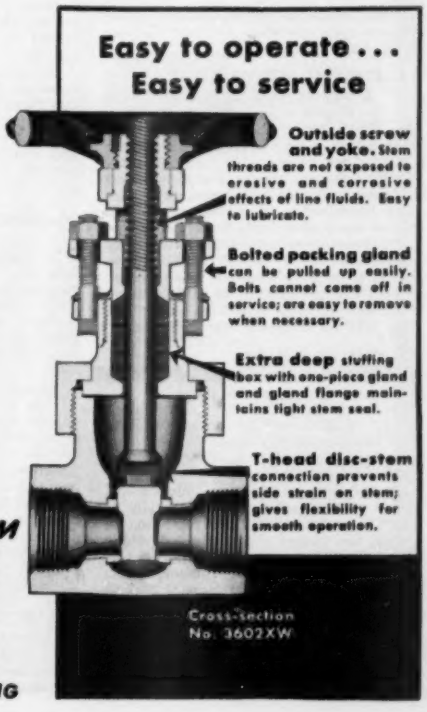


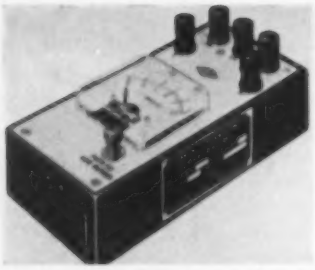
No. 3602XW, 600-Pound Small Steel Gate for steam up to 850° F; for water, gas, air up to 500° F. Hardened stainless to Exalloy Seating. Sizes: ¼ to 2-inch. Screwed or welding ends.


Easy to operate . . .
Easy to service
Outside screw and yoke. Stem threads are not exposed to erosive and corrosive effects of line fluids. Easy to lubricate.
Bolted packing gland can be pulled up easily. Bolts cannot come off in service; are easy to remove when necessary.
Extra deep stuffing box with one-piece gland and gland flange maintains tight stem seal.
T-head disc-stem connection prevents side strain on stem; gives flexibility for smooth operation.
Cross-section
No. 3602XW

EVERYTHING FOR EVERY PIPING SYSTEM

CRANE

VALVES • FITTINGS • PIPE • PLUMBING AND HEATING



joints or connections or grounding. Its meter has four current ranges: 1.25, 2.5, 5 and 10 amp. Set is 7¼ by 3⅞ by 3⅛ in. and weighs 2 lb. It's housed in a non-conducting plastic case. When held in the hand all leads extend away from the operator, so he's in virtually no danger of coming into contact with live parts, it is pointed out. The Eastern Specialty Co.

10—SOUND LEVEL METER

For measuring machinery noise, power station, transformer noise levels

The Type 410-A Sound Level Meter is the size of a flashlight and weighs a little over 2 lb, but it covers the range from 34 to 140 db above the standard ASA weighting characteristics which duplicate ear response at various loudness levels. Owes its compact design to use of sub-miniature tubes and hearing-aid batteries. Non-technical personnel can operate it, company says, because of its simple controls.

Batteries for this meter are readily available and have a normal operating life of 50 hr. Optional accessories include carrying case, extension cable with input adaptor and mounting tripod. Vibration pickups and integrators are also available. Hermon Hosmer Scott, Inc.

11—ELECTRICAL PLUG BODY

Is built for hard use and features a neon glow lamp

The Model 1200 Plug Body is a nylon-housed screw-type electrical receptacle intended for places where constant use results in wear, breakage and frequent replacements. Manufacturer says this plug body will last a long time and can be replaced quickly when necessary.

The neon-glow lamp built in the body makes an easily-found light; it also serves as a pilot to show when power is on. The glow lamp is said to have a life in excess of 25,000 hr, using less than 1/10 w. Industrial Devices, Inc.

12—CLUTCH PULLEY

Is variable speed device automatically controlled by engine speed

This automatic variable speed clutch pulley is designed to permit infinite gear changes on any kind of machinery on which a variable speed belt can be used. The clutch itself is centrifugally operated and allows for independent action on the pulley belt by means of an intermediate ball bearing. This is set on the pulley shaft; the belt rides on it when engine speed is reduced and the pulley is in an idling position. With acceleration, the pulley belt is picked up by the pulley with no wear on the belt. The starting load is thus picked up gradually without strain.

Ratios can be increased or reduced, depending on belt width used. The horsepower capacity is limited only by the belt capacity. The clutch is described as simple and safe. Among the many advantages heralded for it are the prevention of starting overload and the elimination of wear on belts when the clutch is in an idling position. The Driv-Way Lite Co.

13—SLIDE COMPARATOR

For checking pH and chromate content in corrosion control of coolants

This plastic slide comparator is a doubly-useful testing outfit since you can use it to determine both pH and chromate content of the cooling fluids in air conditioning systems, refrigerating brines, diesel engine cooling systems, condenser cooling water.

The base of the comparator contains two vials of pH indicator solution with 0.5 ml pipettes and five 5 ml tests tubes. Each color standard slide contains five pH standards (cresol red pH 7.2, 7.6, 8.0, 8.4, and 8.8) and four chromate standards with values suitable for the application. The value of each standard is engraved on the slide. Complete comparator is 10 in. long, 2⅛ in. wide and 4 in. high; it weighs 1½ lb. Color standards are guaranteed against fading. W. A. Taylor & Co.

14—CHEMICAL FEED CONTROL

Feeds continuously and proportional to flow of water entering tank

In this electro-chemical unit, water flows through an integrating raw water meter. The integrator makes an electrical contact when a predetermined quantity of water has passed through the meter, thus starting the control unit and a time switch which limits its operating time.

The quantity of chemical solution is always proportional to the flow of water. The ratio of solution fed is varied by turning a knob on the dial of the time switch; the quantity of chemicals fed is varied by changing the density of the solution.

Manufacturer says this control is outstanding for its accuracy, ruggedness and flexibility. There's a dial gage on the control unit, in view of the operator, and a remote control dial (which will synchronize with the one on the control unit) is available. The Permutit Co.

15—MERCURY PLUNGER RELAY

Two-pole type, available with contacts normally open or closed

This new design, the Type EM-4, incorporates two of company's standard EMT tubes in one coil structure to produce an efficient arrangement for loads up to 35 amp 115 v a-c, or 25 amp 220 v a-c with minimum size and cost.

Overall dimensions are 4⅜ in. high by 3⅜ in. wide by 2¼ in. deep. For special applications you can get this relay with one contact normally open and the other normally closed to permit instantaneous switch from one circuit to another. Reliability of the relay is credited to dustproof structure—heavy tungsten contacts in a rugged, hydrogen-filled glass tube. Contact is made from mercury to mercury when internal magnetic plunger is energized. Ebert Electronics Corp.

16—SHORT-STROKE SOLENOID

With cast-permafil coil assembly, is built for extra long service

Company engineers say this solenoid has a life expectancy of 5 to 10 million operations. Its basic component is a paper-layer-wound coil that holds voltage between turns to a minimum, and so reduces possibility of failure due to reduced voltage between turns. Foot-long Flamenol leads are firmly taped, and the coil placed in a mold into which liquid permafil is poured. Reactors are added, and the permafil hardens quickly. Then the coil assembly is baked. This is said to result in a solid block around the coil that won't crack and is moisture-, oil-, shock-, and vibration-proof.

Although originally designed for high-speed pilot valve operation, the new solenoid is suggested for any heavy-duty application requiring a push-type solenoid with short stroke. It comes in four models, with strokes of ⅛ and 7/16 in. and two stacking thicknesses. The coil can be changed easily, according to its designers; removal of two bolts lets the backstop and plunger slip off easily and release the coil. Control Divs., General Electric Co.

17—VENTILATING FANS

Have direct-drive enclosed motors designed for low speed operation

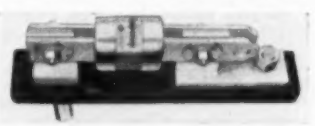
The Series 16 Ventilating Fans are described as quiet and especially adaptable for handling lint or dust laden air. Company engineers point out that outside air doesn't circulate through the motor enclosure—cooling is done by heat transfer through metal of the hub and housing. The fans come in 3- to 5-ft dia sizes and in 11,000 to 30,000 cfm capacities. For corrosive applications company will construct these fans in any workable metal that's commercially available in sheet form. The Moore Co.

18—CURRENT LIMITER

For protecting electrical installations against damage by short circuits

The Amp-trap is a current limiting device for use with low voltage switchgear, bus ways, circuit breakers, transformers. By combining high current interrupting ability with fast action, the Amp-trap cuts off the current before it can build up to dangerous levels.

Amp-traps come in models and ratings to match electrical characteristics



of old and new power installations. They're said to have high interrupting capacity regardless of their current carrying capacity; because they are directly responsive to rate of rise of short circuit currents, their speed of action automatically matches the circuit requirements. The Chase-Shawmut Co.

19—LAMP-TYPE ANNUNCIATOR

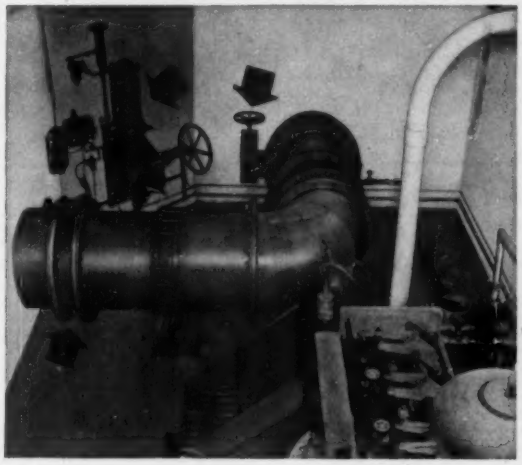
Is good looking, economical and flexible in arrangement

An analysis of problems encountered by industries and utilities in using lamp-type annunciators is credited with many new design features incorporated in this one, such as the use of high-rated midget relays with short armatures to reduce damage by temperature changes and shock.

Control relays are mounted in the same enclosure with the annunciator proper, and all leads brought out to

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



TULSA WATER SUPPLY

Increased in Record Time

The City of Tulsa Water Department increased its water supply from twenty-four to minimum requirements of thirty-five million gallons a day without constructing a second gravity flow line. This was accomplished by means of booster stations at strategic points.

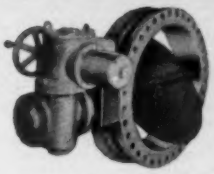
The fifteen R-S Valves supplied for this emergency operation ranged in size from 36-inch handwheel operated to 60-inch air cylinder operated with handwheel declutching units. After delivery, these valves were slipped into the line in a matter of hours. The entire project was completed in remarkably fast time.

Due to an improvement in vane design, the flow rate in R-S Heavy Duty Valves (12-inch and larger) has been increased approximately 25% in the wide open (77½°) position. In case after case, the saving in pumping (or blower) costs will pay for an R-S Valve in short order based on "K" values alone.

Consult with your local R-S Valve Engineers. Look for the address and phone number listed under "R-S Products, Valves" or write direct.

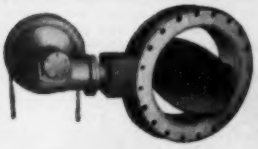
R-S PRODUCTS CORPORATION
Wayne Junction • Philadelphia 44, Pa.

No. 700—20-inch 50-pound Cast Iron Valve with rubber seat, Type B-8934, for positive 100% shut-off. Heavy duty handwheel control with threaded reach rod. Type B-9469.



No. 724—42-inch 50-pound Heavy Service Valve, B-9813, complete with limitorque motor and gear reduction drive No. 4. Angular seating vane for wedge-type closure with metal seat. Rubber seat available if desired. Valve body good for 125 psi gauge static head and drip tight shut-off at 50 psi pressure drop with rubber seat.

No. 768—66-inch Fabricated Steel Handwheel Operated Valve with ends scrafted for welding. 6½-inch diameter one piece Stainless Steel shaft mounted on thrust bearings (valve installed with shaft vertical). Horizontal and vertical ribs on body prevent distortion when machining and assembling. Stuffing box easily repacked. Used to control river flow during dam construction. Open atmospheric discharge.



No. 737—20-inch 50-pound Heavy Service Valve (B9804) with rubber seat (B8934). Gear reduction drive No. 3 with chainwheel.

terminal blocks. Connections are accessible from the front. Other advantages are reported in the use of reinforced bakelite lamp compartments and in the anodized satin-finish aluminum frames which look well on control boards.

Annunciator has 16 engraved Lamacoid windows, 1 by 3 in. Their design permits division into two smaller windows, or the use of 1-in. sq space to serve as pilot light when trouble signal has been acknowledged, or to mount an individual silencing switch. King Products Co.

20—HYDROSTATIC TEST PUMP

Is self-contained, ready for operation when air supply is connected

According to manufacturer, the Airoymetric Pump can be set to build up any desired hydraulic process pressure up to 25,000 psi—and maintain that pressure automatically by stroking, when necessary, to take care of any recurring pressure drop in the system. Its advantages are simplicity, automatic operation and, where air input is properly balanced, the impossibility of exceeding the required hydraulic pressure in the system.

The pump is recommended for testing boilers, pressure vessels, pipe and piping systems, hollow forgings, vacuum pumps and valves, chambers and dryers—also for calibrating and testing pressure gages at pressures up to 25,000 psi. Pump is operated at full stroke length and maximum strokes per min until predetermined hydraulic pressure in the system is approached. Then pump automatically slows down to speed needed to maintain required hydraulic pressure. Milton Roy Co.

21—ADJUSTABLE WRENCHES

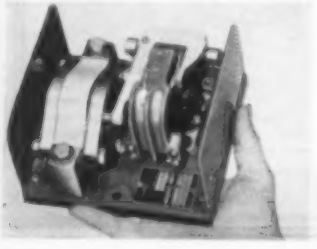
Of drop forged alloy steel, designed to cover wide range of sizes

These two wrenches adjust to 29 sizes. The smaller one, No. OA-24, is 24 in. long, $\frac{7}{8}$ in. thick and weighs only 10 lb. The larger wrench, No. OA-36, is 36 in. long, $1\frac{1}{8}$ in. thick and weighs 22 lb. The smaller size adjusts from $1\frac{3}{8}$ to $2\frac{7}{8}$ in., and the larger from $2\frac{1}{8}$ to $4\frac{3}{4}$ in. These wrenches are intended to reduce weight and number of wrenches necessary far service or maintenance man to carry. Owatonna Tool Co.

22—MAGNETIC AIR VALVE

Uses rotary action for high capacity, fast operation in small size

This air-operated magnetic valve is only 4 in. wide, $6\frac{1}{2}$ in. high and $5\frac{3}{4}$ in. deep. It's designed as a four-way, four port $\frac{3}{8}$ in. valve, for control of a double-acting air cylinder, but can be converted to three-way or two-way operation by plugging the proper ports. Valve cross sectional area is greater than that of a $\frac{3}{8}$ in. standard pipe, and pressures up to 100 psi can be handled.



The valve is intended to operate continuously at 300 cycles per min and speeds to 600 cycles per min on intermittent duty. Its magnet coil requirement is only 38 va at 60 cycles and 215 va inrush. You can mount this valve in any position, and it's suggested for use on welding machines, air-operated clutches, any machines powered by compressed air. Square D Co.

23—PNEUMATIC RELAYS

Are designed to permit time delay adjustment from 0.2 to 200 sec

The Type AM Pneumatic Time Delay Relays have a large graduated dial to permit delay adjustment throughout their 0.2 to 200 sec range for general timing functions. Micro-movement-type precision snap switches with double "make" and "break" contacts (rated at 15 amp, 115 v continuous duty) are used. Additional switches for interlocking can be supplied.

Relays are available as open or enclosed units, the latter in NEMA Type 1 enclosures with conduit knockouts at top and bottom. Operating coils are designed for service down to 85 per cent of rated voltage and coils are available in ratings to 600 v, a-c, 25 to 60 cycles. Westinghouse Electric Corp.

CATALOG LIBRARY

This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions determined by space requirements or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS AND AUXILIARIES

201 Working Pressure Data Card—Maximum allowable working pressures for water tube and fire tube boilers are compiled in a handy reference table, Technical Data Card No. 113 A. It lists pressures in pounds per square inch for seamless and electric resistance welded carbon steel tubes or nipples for different diameters and gages of tubes conforming to ASME specifications. Chart is printed on firm stock, and punched for binding. The Babcock & Wilcox Tube Co.

202 Dowtherm Vaporizer — Bulletin No. 48-3, describing manufacturer's Type "A" Dowtherm Vaporizer tells how this unit is designed to evaporate Dowtherm in such a way as to provide dependable operation at maximum temperatures, discussing its construction advantages in detail. It is illustrated with photos of the vaporizer and includes a dimensional drawing, vaporizer chart and specifications. Also included is table showing general properties of Dowtherm "A." The Wickes Boiler Co.

203 Tube Expanders—Bulletin 380, 8 pp, covers manufacturer's line of tube expanders for maintenance of high pressure boiler tubes, superheaters, economisers, circulating tubes, steam generators and like equipment. Various models are illustrated by photo and described as to application. Also included are engineering drawings to show typical applications of one model. Thomas C. Wilson, Inc.

204 Bent Tube Boiler Data—this 20-pp booklet is filled with engineering drawings of recent installation of company's Class VL boilers, designed for adaptation to limited space conditions in plants having diverse steam requirements. Text covers main design features of these bent tube boilers. Henry Vogt Machine Co.

205 Steam Generators — Engineering data on manufacturer's coal, oil, gas or combination fired package units for generating steam up to 35,000 lb per hour is presented in Bulletin PG-49-13. 12 pp. Includes dimensional data and drawings, a discussion of design features and drawings illustrating firing arrangements. Foster Wheeler Corp.

VALVES, TRAPS, PIPING

206 Piping Materials Catalog—Corrosion resistant valves and piping materials are covered in illustrated circular No. 320. 32 pp. Contains information on manufacturer's complete line of valves, fittings, fabricated piping and pipe coils to meet a wide range of corrosive conditions. Listing includes both photos and cutaway drawings of models, complete specifications, sizes and prices. Includes a description of alloy metals used and a corrosion questionnaire. Also included are several pages of condensed recommendations on the selection of piping materials according to service requirements as well as a pictorial chart showing basic types of valves with names of their component parts. Crane Co.

207 Valves Bulletin—A new catalog section 12-H describes all types of the company's cast steel pressure-seal bonnet valves. Information on choosing the best size valve for your service is given in one page of the booklet under the title, "Correlation of Valve Size and Pressure Drop." Design and construction advantages of the valves are given and tables of pressure and temperature ratings. Details of design including operating mechanism, body design, disk piston, and other features are explained. Dimensional details are given in tabular form accompanied by dimensioned line drawings. A standard materials specification table is presented Edward Valves, Inc.

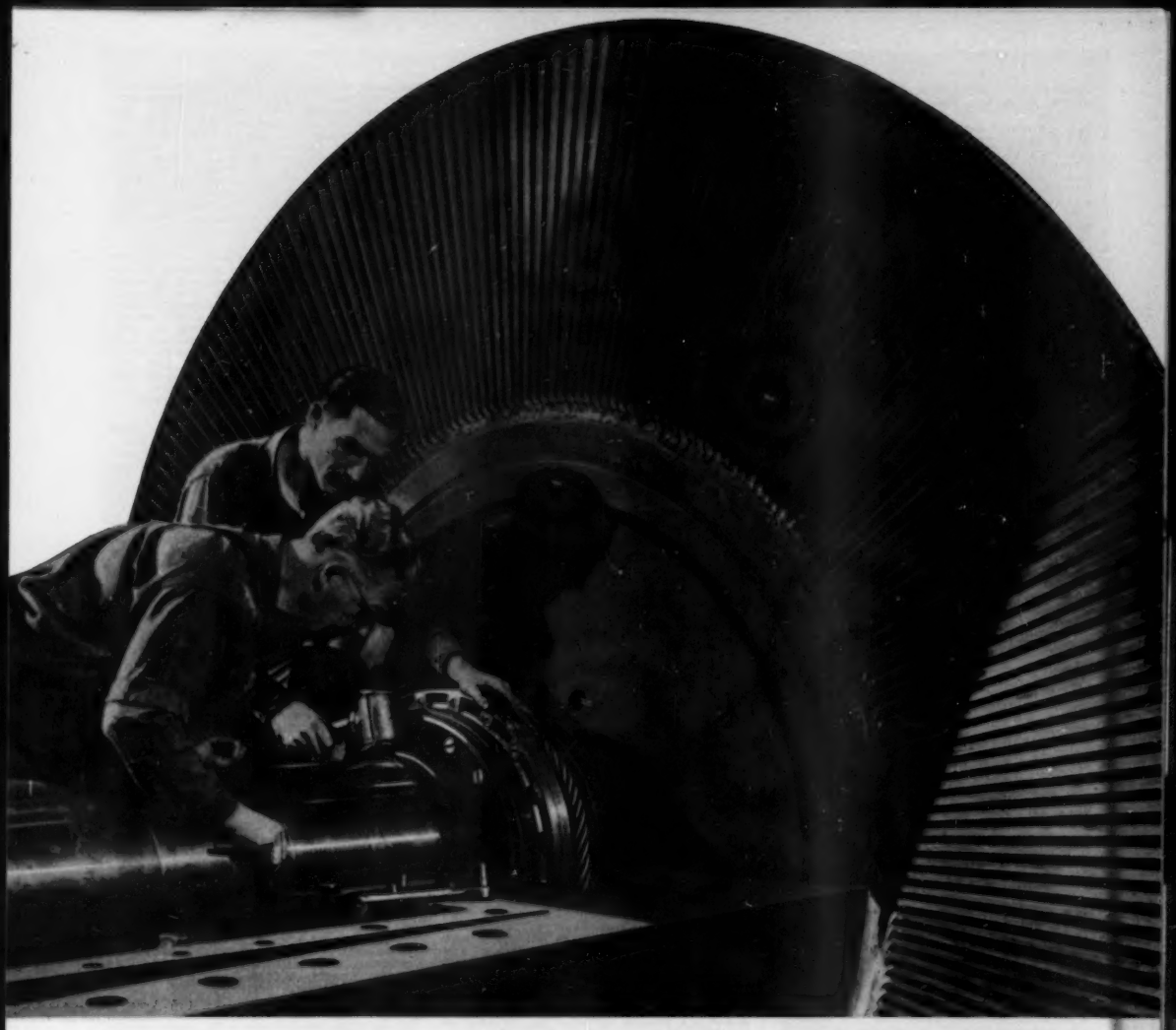
208 Control Equipment—General Catalog 001, 30 pp, is devoted to measuring and control equipment for water and sewage works, power and processing industries. Catalog illustrates and describes in detail: venturi tubes and meters, controllers, gages, manometers, pitot equipment. Includes capacity tables, dimensional data, specifications, layout drawings. Simplex Valve and Meter Co.

209 General Service Valves — Bulletin E-160, 16 pp, describes and illustrates the design and construction of company's quick-operating valves, explaining their application to blow-off service and on fire protection, chemical process, soot blower, water column blow-down, and other types of pipe lines. Included are tables of dimensions, weights and list prices for straight lever and rack-and-pinion types. Inside packed and with outside stuffing box and with screwed or flanged ends. Everlasting Valve Co.

210 Unions and Fittings — Twelve-pp Catalog 50 covers manufacturer's line of unions of all types, elbows, tees and fittings. It describes and illustrates special construction features and other advantages. Also illustrates all equipment offered, along with sizes, materials, current price list. E. M. Dart Mfg. Co.

211 More Data on Strainers—In response to a demand for a former publication on pipeline strainers, this revised edition, Bulletin S-203, 6 pp, is now available. It contains greater and more up-to-date data on screwed strainers as well as expanded details on flanged types. Fully illustrated with photos of the strainers and screens used in them, it explains function of the strainers and provides material specifications, pressure and temperature data, dimensions and prices. Also tells how to install strainers and replace screens. Yarnall-Waring Co.

212 Steam Traps and Temperature Controls—Here is a comprehensive catalog comprising many of company's bulletins on steam traps and related equipment, including an illustrated steam trap chart for easy selection of the right trap for each application. Provides data on boiler steam traps, air eliminators, thermostatic steam traps and air vents, inverted bucket steam traps, temperature regulators and cooling controls, steam and water mixers, thermostats and strainers. Generously illustrated with photos, engineering drawings, catalog contains full dimensional and



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These oils are widely used by industry because of their "Job Proved" record of outstanding service. Experience shows that under normal operating conditions Sunvis 900 Oils *are good for the life of your turbines.* For further information, call or write your nearest Sun Office.

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application information as well as list prices. Barco Co., Inc.

213 **Steam, Air, Gasoline Traps** — This 32-pp illustrated catalog, No. 250, describes five types of thermostatic steam traps for pressures to 235 lb; expansion steam traps for pressures to 250 lb; weight-operated traps for steam, air and gasoline service, pressures to 1500 lb; piston-operated steam traps for pressures to 650 lb, and also steam, air and gas separators. Includes capacity tables, installation diagrams as well as a discussion of typical applications, and a section giving data, charts and formulas for determining proper size trap for specific applications. W. H. Nicholson & Co.

214 **Handbook on Fittings and Flanges** —Catalog wf-1950, 88 pp, is packed with working information on manufacturer's seamless carbon steel welding fittings and forged steel flanges. In addition to presenting standard schedules with their specifications, list prices and sizes, this book gives information on dimensional tolerances; American standard flange facings with dimensions; thread standards and threading practice; service pressure ratings, physical and chemical requirements for flanges, nuts and bolts; plus sizes and wall thicknesses of welding fittings stocked in other metals such as stainless steels, Inconel, pure nickel or Monel, aluminum, deoxidized red brass. Grinnell Co., Inc.

215 **Welding Fittings and Piping Manual** —In addition to data on company's line of welding fittings Catalog 48, 184 pp, contains a 65-pp technical reference section on welded piping systems. Book contains charts, tables, graphs, condensations and discussion of pipe specifications, welding data, design formulas, metallurgical information and other engineering data. There are digests of more than 30 ASA and ASTM specifications covering pipe, fittings and flanges, with a discussion of code requirements for pressure piping.

One section is devoted to tables on working pressures, stress values and pressure ratings, and charts are included for calculation of expansion, modulus of elasticity and flow resistance of bends, fittings and valves. Additional charts show working dimensions of fittings and flanges and over-all dimensions of combinations. More than 100 photos show types of installations and illustrate their use as welding saddles and sleeves. Catalog includes pictorial index. Midwest Piping & Supply Co., Inc.

HEATERS, HEATING

216 **Tubular Heat Exchangers**—Bulletin 916, 32 pp, describes present designs of the company's tubular heaters, coolers, condensers and heat exchangers and their distinctive features. The various types of shells, tube bundles, stationary heads and floating heads are fully explained, together with statements of the particular services for which each is suitable. An additional helpful feature of the bulletin are tables of the characteristics of tubing, the thermal resistance of tubes and pipes of many different metals and alloys and the specific gravity and pounds per gallon corresponding to degrees Baume and API. Also presented are charts of specific heats of midcontinent crude oils and for solving MTD formula with correction factors for other than countercurrent conditions. The Griscom-Russell Co.

217 **Water Heaters**—Illustrated 6-pp Bulletin 70, Section I, on instantaneous type water heaters contains detailed capacity and dimension tables for two-pass, four-pass and six-pass designs, with tube bundles removable for inspection. A typical piping hook-up for installation of these heaters is shown. Also included are instructions for heater selection, engineering data to determine boiler capacities required for heating water, and a chart to determine pipe sizes for any steam flow at most pressures. Davis Engineering Corp.

218 **Condensate Drainage Control** — Manufacturer's system of high-pressure and high temperature condensate drainage control is fully explained in 24-pp Publication No. 3288. Contains useful data on steam flow conditions and heat exchange characteristics. Gives material and operating specifications and capacity ratings for both standard and high differential units in six sizes from 3 to 35 hp based on a maximum of 200 psi above process pressure. Differential pressures to 200 psi are listed and capacities for each unit tabulated for unit inlet pressures. Cochrane Corp.

219 **Combustion Catalysts**—Bulletin 36, 4 pp, explains the action of company's combustion catalysts, including one type developed for use in coal-fired furnaces and another for use in oil-fired furnaces. Tells how they help to remove soot, control smoke and alleviate the slagging problem in boiler furnaces. Also describes a simple hopper-type feeding device available for spraying the catalyst into coal-fired furnaces. National Aluminate Corp.

220 **Unit Heaters** — Illustrated Bulletin TH-3, 8 pp, covers a heater which is driven by a steam turbine, the exhaust from the turbine being piped into the heater section for heating the air. Complete details of the design and construction together with engineering data and dimensions both on the revolving discharge units and the fixed discharge units are included as well as a table on mounting heights and coverage. Piping details are also shown. L. J. Wing Mfg. Co.

221 **Heating Unit**—This bulletin presents advantages of company's gas- or oil-fired self-contained industrial heating unit, explaining its operation, simplicity of installation, and describing and illustrating some of its applications. Includes specifications. Also contains engineering data to help analyze industrial heating problems, including procedures to determine heat load, fuel consumption. Thermobloc Div., Pratt-Daniel Corp.

WATER TREATING, CORROSION PREVENTION

222 **Water Conditioning Bulletin**—This is an eight-page discussion of water and chemicals developed for conditioning it to control scale and algae and inhibit corrosion. Describes several chemicals in detail, giving properties, composition and application. Also includes special purpose chemicals. Wright Chemical Corp.

223 **Corrosion Analysis**—Excellent working data on galvanic corrosion is contained in this 8-pp technical study of corrosion by concentration cells, reprinted from Inco Corrosion Reporter, Vol. 3, No. 1. Discusses concentration cells, the metal-ion cell type, oxygen cell type, reversible concentration cells, their practical aspects and some rules for minimizing or preventing concentration cell corrosion. Illustrated with sketches showing conditions which accelerate corrosion. The International Nickel Co., Inc.

224 **Corrosion Resistance of Nickel Alloys** —Technical Bulletin T-3 contains 44-pp of illustrated information on the resistance of high nickel alloys to corrosion by sulfuric acid. Although technical in nature, it is written so as to be readily understood by non-technical staffs. Performance of 30 nickel-bearing materials in a wide range of service is discussed, and there are 66 tables and 33 graphs and photos. Problems involving a wide range of operations are covered. The International Nickel Co., Inc.

225 **Cleaning Industrial Equipment**—This is a general information bulletin on manufacturer's service for cleaning steam generating, heat exchange and other industrial equipment. Also included is information on pipe line cleaning and water well acidizing. Illustrations of these services are included, and bulletin treats in detail the methods used to remove incrustations from internal surfaces economically with minimum of downtime. Dowell Inc.

226 **Anti-Foam Treatment** — This 4-pp bulletin covers a new formula in powder form to be applied along with anti-scale treatment for improving steam quality, controlling scale in boiler feed system and sludge conditioning. It discusses the problem of steam contamination and explains the action of this polyamide anti-foam treatment. Tells how it should be applied and gives dosage requirements. A discussion of its advantages is accompanied by photos showing the effect of polyamide action on a boiling dilute Nacconol solution. Dearborn Chemical Co.

227 **Boiler Corrosion**—A 12 page article discussing the cause and prevention of corrosion in boiler systems is presented in **Betz Technical Paper No. 111** titled "Corrosion: Its effect in Boiler Systems." The corrosive effects of oxygen, carbon dioxide, ammonia, hydrogen sulfide, acidity and physical factors are evaluated. Numerous illustrations, graphs and tables aid in understanding the article. W. H. & L. D. Betz.

228 **Turbine Blade Deposit Study**—Identification and prevention of steam turbine blade deposits and boiler water conditioning to prevent such deposits are discussed in the new 16-pp illustrated Bulletin **28B7600.** Describes x-ray diffraction methods employed by the company for identification purposes and the results obtained. Tables list the partial chemical analyses of deposits containing sodium disilicate, occurence data on compounds found, composition of turbine deposits from turbines operating at various throttle pressures and temperatures, and comparison of compounds found in turbine blade deposits with boiler operating pressures. Allis-Chalmers Mfg. Co.

229 **Boiler Water Manual**—Factual information on standard methods of applying chemicals in the treatment of water for boilers is presented in this 16-page technical bulletin, called Standard Method 122. Discusses pretreatment of raw water, application of chemical feeding to pre-treating operations and both constant rate and flow responsive feeding direct to boiler drum and to feedwater systems. Also discusses condensate returns, flushing periods, condenser cooling water treatment and chemical tanks. %Proportioneers, Inc.%.

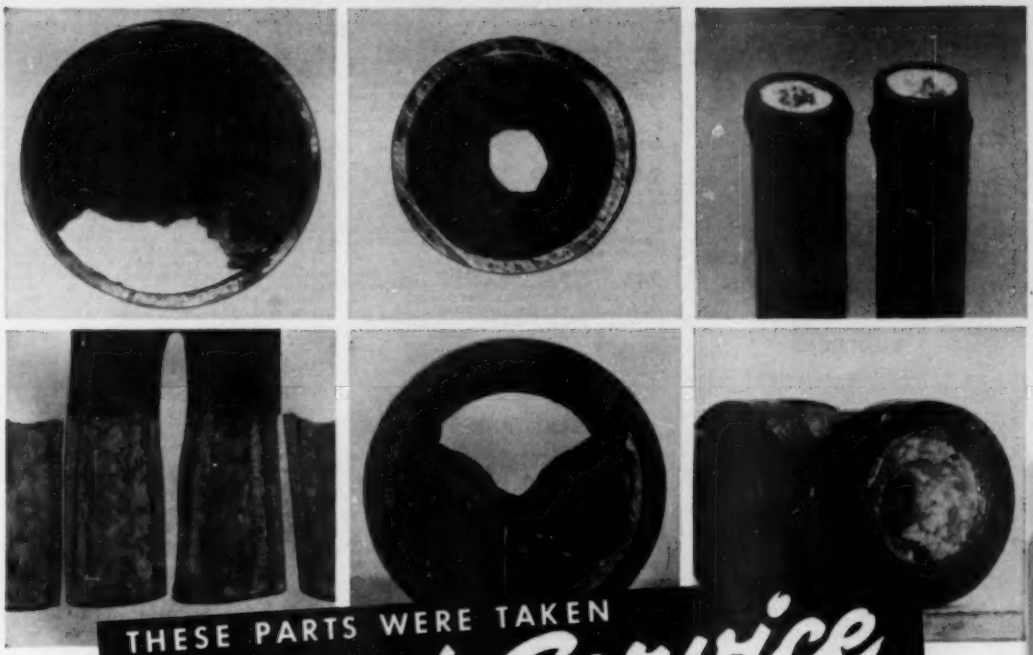
230 **Water Softener Equipment** — How the problems caused by hard water can be offset by the use of water softeners is explained in Bulletin 2386, 12 pp, describing ion exchange equipment. It covers in detail downflow, upflow and gravity zeolite water softeners. Contains a 2-pp cutaway illustration of a fully automatic softener to show how an ion exchanger is built and how it works. Bulletin also contains flow diagrams showing arrangements for installation of water softeners and includes detailed, illustrated discussion of multiport valves used in them. The Permutit Co.

231 **Corrosion Treatment** — "Corrosion Protection of Steam and Condensate Return Systems" is a 4-pp folder covering a recently developed amine treatment for inhibiting of boiler and condensate systems. This treatment is described as affording surface protection of the metal itself as well as raising the pH value of the condensate. Booklet gives specific case histories and typical economies obtained by power plants using this treatment. Includes graphs showing relationship between free CO_2, pH and alkalinity in water, and the solubility of oxygen in water when exposed to air at various pressures The Bird-Archer Co.

232 **Chemical Feed Systems** — Single, complete "packaged" units for feeding directly into boiler feed water lines are the subject of 4-pp Bulletin 4811. It discusses in detail sodium sulfite feeding, internal treatment, chemical feeding, manual control, intermittent feeding of internal treating chemicals; automatic feed systems; automatic pH control, and automatic control by conductivity. Illustrations include photos and diagrams of controlled volume pumps. Milton Roy Co.

233 **Modern pH and Chlorine Control** —The new ninth edition of this 100-pp illustrated 6 by 9 in. paper-bound booklet has been revised to conform with the latest developments and most modern practice in water treatment. But it is much more than a catalog, although it does give full technical details of all the color comparators and equipment in water testing and control of boiler and industrial process water manufactured by this company. Its most important feature, however, is inclusion of much good technical information on the meaning of pH control, electrometric and colorimetric methods of determining pH and also determining constituent impurities in water; applications of water control in air conditioning; treatment of boiler feed water and industrial water, and other industrial applications. Descriptions of color comparators are detailed and illustrated, with the prices listed; and include a new testing set for total hardness of water. W. A. Taylor & Co.

234 **Water Softeners**—Bulletin WC-102 is a 36-pp presentation of recent developments in hot-process water softeners. Explains boiler plant troubles caused by various impurities in water, outlines 12 methods of treating water to eliminate these impurities, describes reasons for the popularity of the hot-process method and its advantages, and explains the chemistry of hot-process water softening. The two basic designs and operation of company's hot process softeners are described, together with six adaptations of each design to various plant conditions, such as per cent make-up, treatment of condensate, deseration. Methods of supplementary hot phosphate treatment are also



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BECAUSE OF SCALE

DEARBORN FORMULA 134 ELIMINATES SCALE

● These destroyed parts represent a large, unnecessary investment in equipment, labor and shut-down time. Conditions like these can easily and economically be avoided with Dearborn Formula 134. Wherever water travels—scale tends to form. Formula 134 is a concentrated solvent for the rapid removal of scale in heat exchange units, boilers, pumps, feed lines, meters, condensers and other valuable equipment.

Formula 134 is just one of many Dearborn formulas used to save equipment, reduce shut-down time and maintenance costs. Other Dearborn formulas control acidity of condensate, prevent excessive foaming and prevent corrosion of metal in contact with calcium and sodium chloride refrigerating brines. For the correct water treatment to best meet your needs—consult Dearborn.

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THE LEADER IN WATER TREATMENT AND RUST PREVENTIVES

WATER TREATMENT AND SOFTENING COMPOUNDS • COMPLETE ENGINEERING SERVICE • NO-OX-ID RUST PREVENTIVES

discussed. Includes more than 30 diagrams of hot process designs and flow charts, together with photographs of installations. Graver Water Conditioning Co.

235 Boiler Water Treatment—Bulletin 47, 8 pp, is on internal treatment of boiler water. Defines internal treatment and tells its advantages in softening, sludge conditioning, stabilization. Explains operation of company's system, including the chemicals used, feeding and testing equipment, and service. National Aluminate Corp.

236 Plant Wide Water Service—Titled, "Let's Consider Your Whole Water Problem," this 4-pp booklet analyzes water problems from four standpoints—procurement, treatment, usage and disposal—and explains how company is prepared to offer technical service in solving problems related to all four. Hall Laboratories, Inc.

ELECTRICAL

237 D-C Generator—Illustrated Bulletin 05B7229, 20 pp, describes the construction of units larger than 150 kw or 0.5 kw per rpm, including two- and three-wire generators and exciters, both engine and coupled type. It also discusses the operation of shunt wound and compound wound generators in parallel, and supplies information on company's marine units. Includes description of "frog leg" armature winding widely used on motor-generator, set generators of 100 kw and larger, synchronous converters of 300 kw and larger and large low speed generators. Allis-Chalmers Mfg. Co.

238 Synchronous Motors — High speed synchronous motors are described in 4-pp bulletin PB 5021-1. The bulletin is packed with descriptive matter and photographs explaining features of the motors rotor and stator. Mechanical modifications also are illustrated. Elliott Co.

239 Time to Retire Your Watthour Meters?—To aid power engineers in determining the economic point at which to retire older watthour meters, Bulletin GEA-5448, 12 pp, offers direct suggestions and includes an evaluator for making the job easy. The evaluator—a plastic circular slide-chart with scales showing cost of new meters, age of old meters etc.—is based on an economic formula developed by company engineers and explained in the bulletin. Use of this formula and the evaluator will assist in setting up planned retirement programs. Comparison of cost of retiring and keeping in service old meters, as determined by the evaluator, answers the question, "When is it economy-wise to retire a group of meters?" General Electric Co.

240 Care of A-C Rotating Equipment—To promote intelligent and consistent maintenance of electrical machines, company has published Bulletin 05R7417, which is a series of articles by Fraser Jeffrey. Contents of the 24-pp booklet cover preventive maintenance and machine repairs, and include such subjects as drying moist insulation, measuring insulation resistance, bearing clearances and typical machine applications. Machine repair chapters include data on stator coil and slip ring rotor repairs, balancing of rotating equipment. Allis-Chalmers Mfg. Co.

PUMPS, COMPRESSORS, ENGINES

241 Condensers—Bulletin 441-C, 28-pp, covers in detail every phase of manufacturer's line of condensers—their simplicity of design, accessibility, construction features. Illustrated with photos and drawings showing complete assemblies, parts, principles of operation. Bulletin also discusses emergency replacements, service and maintenance facilities available, and auxiliary equipment. Includes condenser tube data, pressure-conversion tables. Condenser Service & Engineering Co.

242 Compressor Selection Chart—Here's a new selection chart, based on normal applications handling air with atmospheric intake pressure. It simplifies selection of proper size compressor for average industrial use, with quick comparison between discharge pressure pounds per square inch gage and piston displacement cubic feet per minute and shows recommended compressor bore and stroke in inches. Chart covers two letter-size pages. Worthington Pump and Machinery Corp.

243 Air Compressor Lubrication Manual—Valuable information on air compressor maintenance is contained in this 40-page book on the lubrication of air compressors, second edition. Subjects treated include compressed air, compressors and related equipment, lubricating systems, compressor oils and their applications, lubrication requirements operating hints, oil requirements, storage and care of compressor oils, and safety precautions. All discussions are illustrated. Cities Service Oil Co. (In the South, Arkansas Fuel Oil Co.)

244 Centrifugal, Reciprocating Pumps—This helpful collection of bulletins covers all types of centrifugal and reciprocating pumps for a wide range of industrial uses. Contains more than 80 pp in all and includes photos, dimensions, specifications, ratings and application data. Warren Steam Pump Co.

245 Modern Steam Engines—In presenting steam engines as more than "just drives," Bulletin 306 touches briefly upon some of the advantages of "by-product" power. Bulletin features company's vertical steam engines of both throttling and automatic governor types. Sectional drawings are accompanied by engineering data, an illustrated discussion of construction features and photos of installations. Troy Engine & Machine Co.

INSTRUMENTS AND CONTROLS

246 Smoke Density Recorder—Bulletin 211, 4 pp, tells how company's bolometer-type smoke density recorder promotes efficient furnace operation and how it helps in the battle against smoke nuisance. It describes and illustrates the smoke detector which consists of a bolometer receiving and measuring radiation from a sealed beam light source. Recorder specifications, installation requirements, and measuring circuit details are also discussed. Bailey Meter Co.

247 Boiler Water Level Control — Bulletin 427 describes completely the installation of boiler water level control equipment at the Blackhawk Generating Station, Wisconsin Power & Light Company. Photographs of the installation are presented as is a schematic layout of the entire station along with tabulated significant data. Northern Equipment Co.

248 Instrument and Control Panels—Bulletin 773, 8 pp, explains how company's panels are made and where they are used. All operations of fabrication are discussed and illustrated—layout, cutting, drilling, welding, fitting, painting, wiring. Particular features like electric clocks, pressure gages, transformers, name plates, push-button stations and signal lights are discussed. Also included many photos of panel installations covering all sizes, shapes and designs. The Hays Corp.

249 Remote Reading Flow Meters—Data Book 702, 32 pp, fully illustrates and explains flow measurement problems and offers suggestions for their solution. Meter bodies, differential devices and reading instruments are fully described and a special section is included on wide range and reverse flow. Numerous illustrations relate an informative pictorial story on fluid flow measurement. Republic Flow Meters Co.

250 Flow Meters—Illustrated Bulletin M-31, 4 pp, explains how automatic compensation for pressure or temperature variations, or both, are achieved in flow measurement of gases or liquids with company's compensated meters. A schematic diagram shows how a corrected record is automatically and continuously produced, with the chart also showing uncorrected flow. Another diagram illustrates installation of a pressure and temperature compensated flow meter, and photos show the meters equipped for compensating functions. Hagan Corp.

251 For Practical Men—That's the title of this 24-pp pocket-size booklet presenting insulation testing in simple language. Packed with maintenance hints, it explains electrical insulation, tells how it can be tested and what makes it go bad. It describes the Megger insulation tester and justifies its cost in terms of long run economy and prevention of shutdowns. Discusses the Megger as a trouble-shooter, pointing out its functions and telling how to get the most out of it. There's also a chapter on handling wet equipment. Photos, line drawings and humorous sketches accompany the text. James G. Biddle Co.

252 Flow Meters—Bulletin 400-F2, 8 pp, features company's meter for measurement of steam, air, or gas flow in 1 or 1½ in. pipe lines, and designed for installation directly in the line being metered. Illustrated with photos of meter, sectional and dimensional drawings, the bulletin explains how meter operates and discusses its advantages. Gives typical specifications and includes correction factor charts and capacity tables. Builders-Providence, Inc.

COAL HANDLING

253 Coal Scale Data Book—The answers to a power engineer's questions on coal scales are provided in this excellent 48-pp book, Bulletin 1143, covering scales for recording weight of coal consumed by individual boilers and weight of coal receipts from ship, car, truck or storage. It is generously illustrated with photographs of models and accessories and actual plant installations and contains all necessary engineering drawings, dimensional data and detailed specifications. Construction features and operation of weighing and feeding systems are described. Richardson Scale Co.

254 Spreader Stokers—Catalog 80, 44 pp, describes a spreader stoker with forward moving grate that slowly and continuously discharges ash at the front. Explains the efficiency and economy of this stoker, illustrating grate's design and operation. Includes discussion of typical power plant installations of these stokers, covering more than 30 industrial, institutional, municipal and public utility installations through the country. These are illustrated by photos and blueprint drawings. Detroit Stoker Co.

255 Coal Handling Equipment—Modern equipment for the storage and handling of coal and ash is presented in 24-pp Bulletin 309. Illustrated with sketches and photos of actual installations, it covers concrete and tile silos, cylindrical steel tanks, and suspended steel bunkers with gravity discharge bucket elevators and pivoted bucket carriers. Gifford-Wood Co.

256 Spreader Stoker—Bulletin SB 31, 4 pp, explains and illustrates, by photos, the design and construction features of company's spreader stokers, stressing their advantages. Also contains photos of installations. Erie City Iron Works.

257 Small Crushers—"For Better Testing and Small Scale Reduction" is the title of this 6-pp bulletin describing in detail the many practical applications of company's small crushers, grinders, and shredders for the reduction of coal, by-products, chemicals, clays and many other products. Typical installations are clearly diagrammed and explained. Special attention is devoted to construction features and functional advantages of the different mills as applied to various reduction jobs. American Pulverizer Co.

TURBINES

258 Turbine Catalog Collection—This is a valuable collection of bulletins in loose-leaf form. They cover a complete description of manufacturer's solid wheel turbines and feature cross section drawings of typical units for both moderate and high steam pressure conditions. Also provides a description of an axial flow impulse, both single and multi-stage, and complete data on speed increasing and speed reduction gears. The Terry Steam Turbine Co.

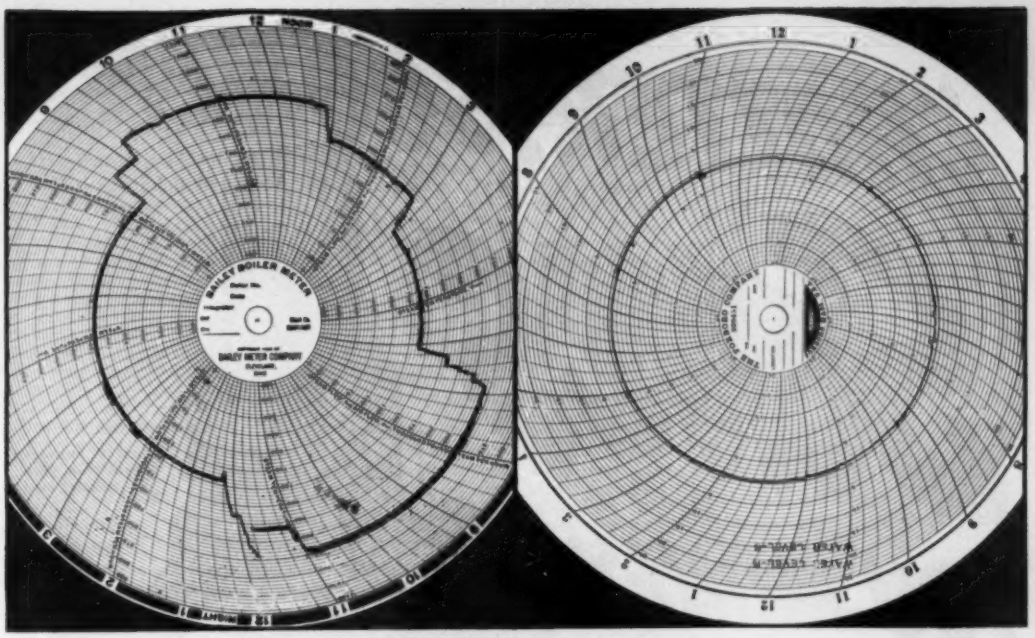
259 Velocity Stage Turbines — Catalog 82-19R, 8 pp, features turbines for mechanical drives designed to operate under all inlet steam conditions up to 600 psig and 750 F. Gives complete specifications, dimensions and includes chart showing how to estimate turbine sizes. Illustrations include cutaway view, photos of parts, Speed governor and regulating valve, and emergency governor and trip valve are described. De Laval Steam Turbine Co.

260 The Answers on Turbine Oil—This 2-pp booklet answers several questions power engineers ask about turbine oils, including: What causes deposits of sludge? What causes acidity increase? What causes corrosion in turbines? Explanations are brief but thorough. Booklet is illustrated with photos of turbine installations in which manufacturer's products have been used successfully. Standard Oil Co. (Indiana).

DUST COLLECTING

261 Fly Ash Elimination — Power engineers will find this 30-pp booklet outstanding among material on this subject. It presents manufacturer's "Multi-

(Continued on page 109)



Left: Steam flow from B & W Type FH Boiler rated at 275,000 pounds per hour, 900 psi, 910 F. Right: Drum level held within ±½ inch by COPES Flowmatic

The most important boiler plant in the world is yours

You hear a lot about one plant or another being important. But no other plant in the world is as important to you as the one for which you are responsible. All any other plant means to you is a chance to learn how to better your own.

Take the boiler from which the charts above were obtained. That it is one of the largest Babcock & Wilcox Integral Furnace Boilers ever built concerns you only because operating experience with it can help you with your own operation.

Study the charts carefully. How do your loads compare? Do you have such sudden sharp changes in rating? Is your drum level held as closely despite the changes? It can be —if your boilers, like this one, are equipped with COPES Flowmatic feed water control. And simple routine care by plant personnel takes care of all maintenance.

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Yarway Impulse Steam Trap with new stainless steel body.

Yarway Impulse Steam Traps get equipment hot and into production *faster*. Extra profits!

Then they keep it *continuously* at peak operating temperatures for maximum production. More extra profits!

What's the reason for *hotter, sooner?* Just this. When steam is turned on, Yarways open wide, discharging the air and condensate *in a hurry* —closing only when steam arrives. Then, when operating temperature has been quickly reached, the little valve (only moving part) literally *floats on the load*... discharging heat-retarding condensate as soon as it forms instead of waiting for quantities to accumulate. Thus equipment is held at peak operating efficiency.

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Nest of Yarway traps installed with Yarway Strainers on cloth dryer. Note small space required.

Stainless Steel Body

YARWAY IMPULSE STEAM TRAP

LETTERS TO THE EDITORS

MOTOR IDENTIFICATION

MY SUGGESTION to Mr. Shortridge is that he use the system that is used in power plants, and stencil the required data on the motor frames. Use a color for the lettering that will show up plainly against the color of the paint on the motor.

I do not know the conditions prevailing in Mr. Shortridge's plant, so I cannot suggest any specific form of code. Also, if some of his motors are quite small in size, the code must be such that it can be read from a convenient distance.

One suggestion for a motor identification might be like this:

12 - 50
3 - 440

This would mean Motor No. 12, 50 horsepower, 3-phase, 440 volts. This would identify this particular motor either in place in actual operation or as a spare in the warehouse.

For small motors, which are all single-phase and 110 volt, the stencil might read 8-5, meaning motor number 8 and 0.5 horsepower, or 8-½.

HOWARD T. LIVINGSTON

MORE USES FOR THE HOOK-ON METER

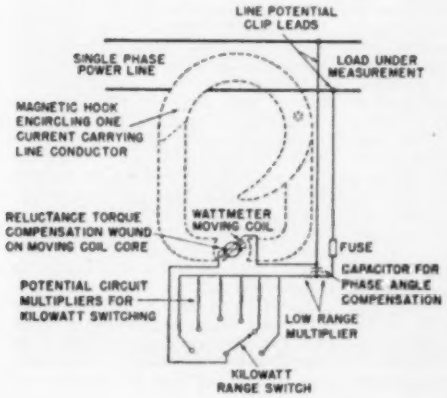
ALTHOUGH the hook-on ammeter is not a new instrument, from the recent discussion of this instrument in these pages, there seems to be a great deal of renewed interest in this type of meter. Or is it that operators are just learning about this valuable instrument?

Those who have discovered the many purposes to which the hook-on ammeter can be applied will be interested to know of a recent development in this field of measurement—the hook-on wattmeter. So far the available self-contained instruments are limited to current measurement. Interest in extending this method of measurement to active and reactive power has resulted in the development of a self-contained hook-on wattmeter.

As described by A. J. Corson and A. L. Nylander of the General Electric Co. in the July issue of *Electrical Engineering*, this new hook-on wattmeter has a range of from 3 to 300 kw. Of course in the measurement of power it is necessary to measure the voltage of the circuit as well as the current and in the hook-on wattmeter this is accomplished by a separate pair of clips which are clipped across the circuit as shown in the accompanying diagram. It is a ferrodynamic wattmeter, the field of which is energized by the current carrying conductor through the hook. By making this field linear with respect to the current through the hook, and by using a spring-controlled moving system, the scale capacity is directly proportional to the potential circuit resistance. Range changing is, thus, accomplished by potential switching alone.

The scale distribution for the six ranges is substantially linear. It is influenced by the linearity of the hook magnetization curve and by the moving-coil reluctance torque. This reluctance torque is due to the circumstance that the total flux linking the moving coil, as a result of moving coil magnetomotive force only, is a function of coil position. The effect is usually negligible but in the hook-on wattmeter, with its necessarily wide range of moving-coil magnetomotive force, the error is appreciable.

NEW YORK, N. Y. HOWARD GIBSON


LINE POTENTIAL CLIP LEADS
SINGLE PHASE POWER LINE
LOAD UNDER MEASUREMENT
MAGNETIC HOOK ENCIRCLING ONE CURRENT CARRYING LINE CONDUCTOR
RELUCTANCE TORQUE COMPENSATION WOUND ON MOVING COIL CORE
WATTMETER MOVING COIL
FUSE
CAPACITOR FOR PHASE ANGLE COMPENSATION
POTENTIAL CIRCUIT MULTIPLIERS FOR KILOWATT SWITCHING
LOW RANGE MULTIPLIER
KILOWATT RANGE SWITCH

Measuring single phase power by means of the hook-on wattmeter

SINGLE PHASE FROM 3-PHASE

THE ARTICLE on single phase power from a 3-phase source by R. Bruce Jones in the June issue is most interesting and valuable in its application to general use in a distribution system. The availability of a modern load center unit puts to work equipment of a type definitely suited to the purpose.

Some 30 years ago the writer was

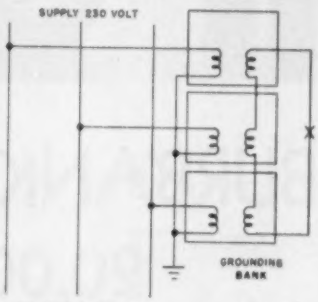


Fig. 1

faced with an industrial application where the maximum voltage permitted was 230 and the distances of appreciable length from the substation with one-phase loads of large capacity. No step-down substations were allowed on the property area other than at the main point of supply. To obtain 115 volts for lighting and lower voltage applications, an auto-transformer 230/115 volts was placed in the feeder to each load center at the point of distribution just ahead of the panel making possible a feeder of 230 volts from the substation control board and 3-wire distribution from the load center. The substation transformer supply bank was 230 volts delta and since the state law required a limit of 150 volts to ground for lighting circuits a star-delta 3-phase bank of 25 per cent of the total load capacity was installed as indicated; which made possible a nominal value of 133 volts to ground. At point "X", Fig. 1, a variable resistor was installed, adjusted to limit the ground fault current. It is, of course, obvious that with a 208/120 volt system the neutral of the main bank can be grounded.

It is of course, necessary where one-phase load predominates to make every effort to connect the loads to make a balanced system as close as possible. The advantage of using auto-transformers to obtain 230/115 volts is the possibility of absorbing the one-phase unbalance

(Continued on page 92)

Fig. 1. A view of the Burbank Power Plant from the lobby of the new Public Service Building. The attractive modern architecture of the power plant and the landscaping make this one of the most "easy to look at" power plants in the country

BURBANK Adds New 20,000-kw Generating Unit

Growing power needs of The City of Burbank, California has made it necessary to make two additions since it was built in 1940. A new 20,000 kw generating unit was placed in operation last fall and now a new bond issue has been voted on for the installation of a fourth unit in the near future

By W. FREEMAN SMITH

STEADY READERS of *Power Plant Engineering* may recall an article published back in 1940[1] describing the opening of Burbank's first power generating plant. This article was based on material supplied by J. B. Johnson, Chief Mechanical Engineer of the Burbank plant.

One of the outstanding features of this plant was its semi-outdoor construction, with the boiler and control panels exposed and the turbine generator mounted on an exposed deck. Carl A. Hienze, the consulting engineer, was principally responsible for this innovation. Another feature of this new station widely commented on by designers was its distinctive building architecture, distinctly modern, which together with an attractive color scheme and landscaping, made the Burbank a notable showplace.

Ten years have elapsed since the opening of Burbank station and during that time the load has grown. To meet this increased load the plant has been extended, first in 1943 and again, recently, in 1949.

On August 11, 1949, the new Administration Building was formally opened. This building has the same architectural design and color scheme as the structure housing the power generating equipment. This ceremony marked another milestone in the Public Service Department's comprehensive modernization and expansion program for its electric and water systems. This program, initiated shortly after the close of the war, involves the rehabilitation and extensions of the water and electric distribution and transmission systems, substations, street lighting, pumping stations and reservoirs. It is the new generating unit, however, which is of most interest.

To the original 10,000 kw unit, a similar unit was added in July 1943. Then last year, a third unit was put into service on November 16.

Before describing the general design of this third generating unit, a short history of the Burbank system may be of interest. The phenomenal growth of the municipality of Burbank, California, from a population of 515 in 1911 to over 83,000 in 1949, with the concomitant industrial and commercial growth accounts for the equally interesting expansion in the power requirements of the community. As early as 1913, Burbank got into the electrical power distribution business by a bond issue of $20,000. At that time, the city was supplied by means of a 2200-v 3-phase, 50-cycle line, the power being purchased from Southern California Edison Co.

The amount of power used grew with the population and in 1931 the City contracted to buy power from Hoover Dam. This contract called for a purchase of 25,000,000 kilowatt hours annually for a period of 50 years. This was thought to be sufficient capacity for the foreseeable future. By 1937, however, this allotment was too small, so once again the City bought power from its neighboring municipalities, Los Angeles and Glendale. It was during this period that the decision to

[1] California Goes Modern, September 1940. Page 52.

build a municipal generating plant was made. It is obvious, therefore, that, compared with other cities in the East, Burbank's power plant experience has been comparatively short, but it has been gratifying.

Now, with the additional power provided by the recently installed unit, they are able to generate virtually the entire system load, which at peak amounts to 42,500 kw. Under the contract with the Bureau of Reclamation they must still use their allotment of power from Hoover Dam. Additional future power is being planned for and the plant area and the buildings have been designed to make further generating capacity feasible.

Features of Unit No. 3

As indicated in the accompanying list of equipment involved in the installation of Unit No. 3, the new generating unit is a 20,000-kw machine, designed for operation at 850 psig and 900 F. The boiler is rated at 215,000 lb per hr and is designed for a pressure of 1000 psig.

The new turbine is installed outdoors like its predecessors on the same deck and served by the same gantry crane. As this article is being written, it is announced that Burbank voters have approved a $2,500,000 bond issue for still another unit to be built and installed sometime during the next three years. This will be a 30,000-kw machine. This unit will require further extension of the building.

Since going into operation last fall, Unit No. 3 has measured up to contract specifications, indeed, in some respects it has exceeded them. The over-all efficiency of this machine is 28.6 per cent. This figure is on test conditions and it is expected that it will slip somewhat under normal operating conditions. On the whole, the unit has operated very satisfactorily.

The average cost per kilowatt hour from this plant is low, due in part to the high load factor at which the plant is operated, and to a favorable situation currently prevailing in the fuel market. The boilers and equipment are designed to handle either natural gas or oil with equal facility. Gas is purchased on an interruptible service schedule at very low rates compared with firm gas schedules, however, and since independent oil refiners have recently found themselves with a surplus of fuel oil it has been possible to effect very considerable savings through the alternate use of

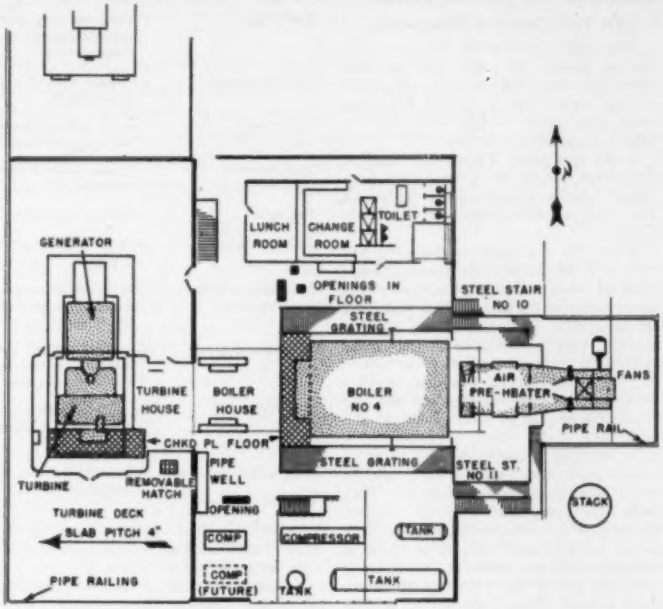


Fig. 2. Second floor plan of Unit No. 3 at Burbank

Fig. 3. A view of the Burbank Municipal Steam-electric plant showing the new 20,000-kw generating unit at the right

these fuels as prices fluctuate. Even with natural gas available at 18 cents per thousand cubic feet, and the advantages offered by this fuel over oil which is trucked in; and with the burning of gas fuel offering savings in furnace maintenance over the maintenance costs when burning oil fuel, the small independent refiners are nevertheless successfully competing with natural gas in bidding for the City's fuel needs.

Low Fuel Cost Per Kilowatthour

The average cost of fuel is currently about 15 cents per million Btu and when the over-all efficiency of the new unit is 11,925 Btu per kwh, the cost of fuel amounts to only 1.0 mills per kwh.

J. B. Johnson, Chief Mechanical Engineer, points to several new features worth commenting upon as they are relatively new on the West Coast.

First, for example, is the recirculation of 20 per cent of the combustion air from the pre-heater. This is done up to 50 per cent of full load of the unit. This departure sounds logical chiefly because its lowered moisture content reduces corrosion of the Ljungstrum pre-heater elements. This prolongation of the life of these plates is economically attractive.

A second feature is the use of compressed air rather than steam to function as soot blowers. This unit is equipped with a Vulcan System. The blower nozzle or jets have air powered valves as well as compressed air controls, making it possible to set up a centralized control panel. Thus an operator can perform this function more precisely and with less effort than formerly when hand operated valves were used. Moreover, the use of compressed air constitutes a saving in that steam is expensive to use for this auxiliary function.

Smog is a reality in Los Angeles County. Considerable efforts have been made to meet the requirements of the Smog Control Authority, and with very satisfactory results. During operation automatic combustion controls largely prevent the formation of smoke; in addition to these controls the furnaces are equipped with smoke detectors which give an alarm if smoking does occur. Additionally, during all soot blowing operations Multi-Clone type of mechanical precipitators are used. Fur-

(Continued on page 106)

LIST OF PRINCIPAL EQUIPMENT
FOR UNIT NO. 3 BURBANK STEAM-ELECTRIC GENERATING PLANT

Equipment	*Description*	*Manufacturer*
Main Turbine-Generator	20,000 kw; 850 psig, steam-pressure; 900 F temperature 13.8 kv generator	Allis-Chalmers Manufacturing Co.
Steam Boiler	215,000 lbs per hr — 1000 psig design pressure	Combustion Engineering Co.
Air Preheater	Ljungstrom regenerative type	Air Preheater Corp.
Draft Fans	Forced- and Induced-Draft fans, direct connected to two-speed electric motors	Westinghouse — Sirocco Division
Main Condenser	Two-pass divided water box — 18,000 sq ft	Elliott Co.
Feed Pumps	Two centrifugal pumps 6-stage, split case	Worthington Pump and Machinery Corp. Elliott motors
Stage Heaters	3-Tubular heaters with drainers	Struthers-Wells Corp.
Deaerator	Tray type with vent condenser	Swartwout Co.
Cooling Tower	Induced mechanical draft type; 5-section	Fluor Corporation Louis Allis motors
Circulating Cooling water pumps	One 20,000 gpm and one 12,000 gpm centrifugal direct connected to motors.	Ingersoll-Rand Co. General Electric motors
Automatic Control	Combustion, feed water, steam temperature and miscellaneous controls, pneumatic type	Bailey Meter Co.
Flow Meters	Condenser cooling water and miscellaneous steam and water flows	Republic Flow Meters Co.
Freight Elevator	Automatic stopping and push-button starting. 3-Ton capacity	Otis Elevator Co.

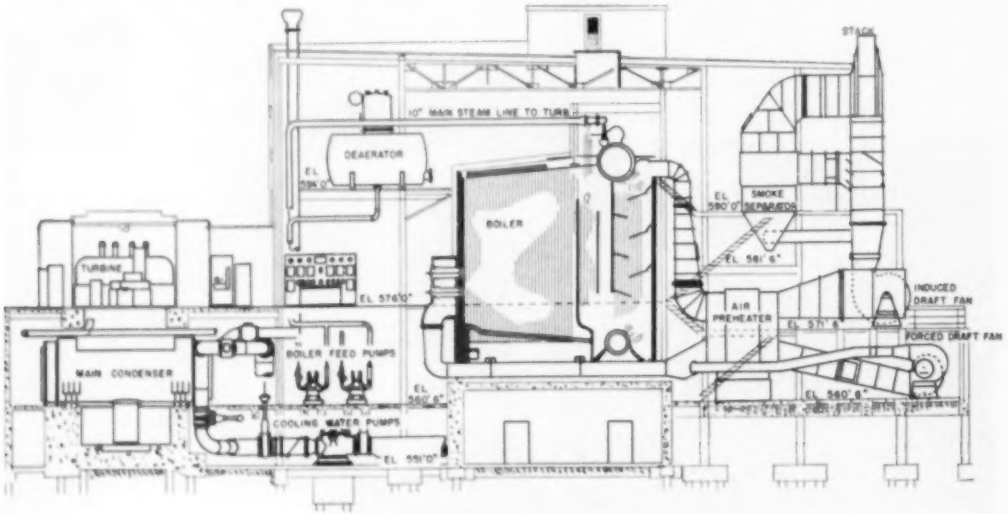


Fig. 4. General cross section of unit No. 3 at Burbank Station

120 Radial Gas Engines Supply Power at Alcoa Plant

One of the world's most unusual power installations supplies the new aluminum refining plant of the Aluminum Company of America near Port Lavaca, Texas. This power plant consists of 120 Radial gas engines each driving a combination d-c and a-c electric generator. Each engine with its auxiliaries constitutes a complete power unit, independent of the other units. The total output of this plant is approximately 2,750,000 kwhr per day

ONE OF THE MOST unusual power plants in the world began operation early this year at the new Point Comfort Works of the Aluminum Co. of America, near Port Lavaca, Texas. This power plant consists of three separate engine rooms, each room housing 40, eleven-cylinder, 1600 hp, spark ignition, radial gas engines, each engine driving an electric generator, generating 1000 kw of direct current at 667 v and 125 kw at 425 v and 24 cycles. The a-c power is used for driving each engine's auxiliaries, thus eliminating the need for a common auxiliary power system. These engines are a new type developed by Nordberg Mfg. Co. of Milwaukee, Wis., and were described in the November 1948 issue of *Power Generation*.

Developed particularly for this class of service these engines offer a number of advantages over conventional turbine type power units. First, the efficiency of these high compression engines is very high, having a thermal efficiency of 29 to 30 per cent. This compares favorably with the best steam turbine practice. Second, their speed is such that they can readily drive direct-current generators directly, thus eliminating the need for rectifying equipment in a plant of this kind where practically the entire load is a d-c load. Another factor of importance is that the manufacture of the 120 engines installed in this plant amounted to what was virtually a production line operation and this reduced the cost of the individual units. And, of course, located where it is in the Texas oil and gas fields, fuel is cheap. While these particular engines are arranged to use gas, they can be built for oil-diesel, dual fuel or spark ignition gas operation. The low cost of gas fuel determined the use of the spark ignition in this particular case.

Before we describe the power plant in greater detail, a few facts regarding the Point Comfort Works may be of interest. This plant produces the first aluminum ever made in Texas. Grading and excavation for the plant began in August 1948 and the first aluminum was poured on February 11, 1950. Between these two dates, a modern aluminum reduction works was constructed on what had been a stretch of Texas ranch land.

The Point Comfort Works has a capacity to produce 114,000,000 lb of aluminum per year. It is located on a tract of land of some 3000 acres in area and consists of 25 buildings with approximately 18¼ acres of floor space. Included in the buildings are the pot rooms where the aluminum is made; the engine rooms already mentioned; a carbon plant; and various plant service facilities. The carbon plant is necessary to produce the carbon which lines the aluminum reduction cells. It takes about 10 kwh of electricity to produce one pound of aluminum.

Each engine room of forty engine units supplies one pot line. In each engine room, the engines are arranged in two rows with a central operating aisle between as shown in Fig. 1. Each engine exhausts into its own exhaust stack set on a concrete foundation outside the building. These stacks are 50 ft high and 7½ ft in diameter and are made of aluminum.

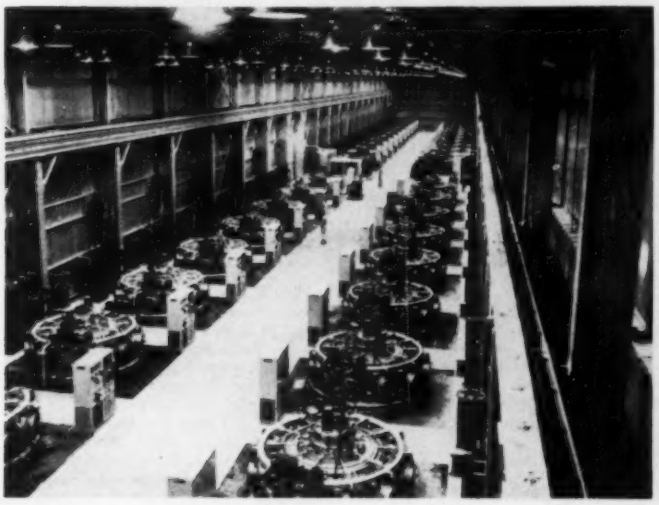


Fig. 1. One of the three engine rooms, each containing 40 radial gas engines. Generators and auxiliary equipment are located on the lower floor

Natural gas is delivered to the works at a pressure of from 400 to 500 psi. This pressure is reduced in two stages to 60 lb. Two 8 in. gas lines connect each of the three power houses with the pressure reducing station. A regulator at each engine further reduces the intake pressure, and in actual operation, gas enters the engine at a pressure of about 6 lb.

Each engine consumes gas at a rate of 13,000 cu ft per hr under load. Normally the plant will use more than 30,000,000 cu ft of gas per day.

Nominal generating capacity of the power plant is 120,000 kw. Under normal operating conditions, the total output of the plant will be approximately 2,750,000 kwhr per day.

Gas Engines

The eleven cylinder engines are 2-cycle units with 14 in. bores and a 16 in. stroke. At Point Comfort, the engines are normally operated at 360 rpm, producing 1600 hp.

The crankshaft is set vertically with the crank at the top. The cylinders are bolted radially to a cast frame, having a central hub that carries both the lower crankshaft main bearing bushing and also the thrust bearing which supports the load of the crankshaft. The heavy, bolted cover contains the upper crankshaft main bearing bushing. The governor, fuel pumps, mechanisms for gas operation and controls are located on this cover. Circular manifolds for scavenging and exhaust are located in the lower level of the engine room. Intake and exhaust are timed by the pistons uncovering ports in the cylinder walls, and no valves are required.

Balanced operation is accomplished by use of a master gear, a stationary gear bolted to the cover, two pinions and rotating counterweights. The eleven connecting rods are attached to the master gear by means of knuckle pins mounted in bronze bushed bearings. The master gear gyrates instead of rotating. There is no master connecting rod, commonly associated with radial type engines.

Two systems of lubrication are used. Motor driven, multi-feed lubricators deliver oil to each cylinder for piston lubrication. A circulating, pressure system provides oil for all other parts requiring lubrication and also for piston cooling.

When set up for gas burning, the engine operates on reduced compression, with spark ignition. Natural gas is admitted by cage mounted gas valves. The valves are operated by a cam on the crankshaft and are so located that gas is admitted into the path of incoming scavenging air. This assures thorough mixing and efficient use of the fuel. A valve inserted in the gas line and controlled by a governor varies the amount of gas delivered to the cylinders according to the load on the engine.

Generators

The electric generators are located in the lower level of the power houses and are joined to the engines by direct coupling. Each engine-generator unit, with its auxiliaries, operates independently. Forty generators were supplied by each of three manufacturers: Elliott Company, General Electric Company, and Westinghouse Electric Corporation.

Each generator produces 1000 kw (d-c) at 667 v and 125 kva (a-c) at 425 and 24 cycles. The a-c power is used for driving the engine auxiliaries. This eliminates the need for a common auxiliary power system and possibility of a total station interruption. The generator is used as a motor in starting the engine.

Auxiliary Equipment

Each engine-generator unit has its own control panel, which includes engine protective equipment. Protective equipment causes the engin to shut off automatically for such reasons as low oil pressure, high water temperature, high exhaust temperature, overspeed, high generator temperature, or loss of auxiliary power.

In addition to unit control panels, each powerhouse has a master control room with recording and indicating equipment registering the operation of each of the forty engines and generators. No unit can be shut off from this master control room, but it provides a central point from which the operation of forty units can be observed.

Centrifugal type scavenger air blowers, which provide air under pressure to the engine cylinders, are driven by a 100 hp motor. These

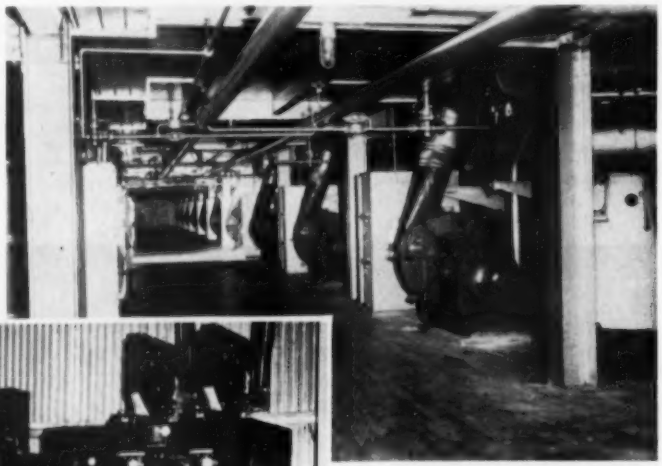


Fig. 2. (Above) A partial view of lower power house floor showing the motor-driven scavenging blowers

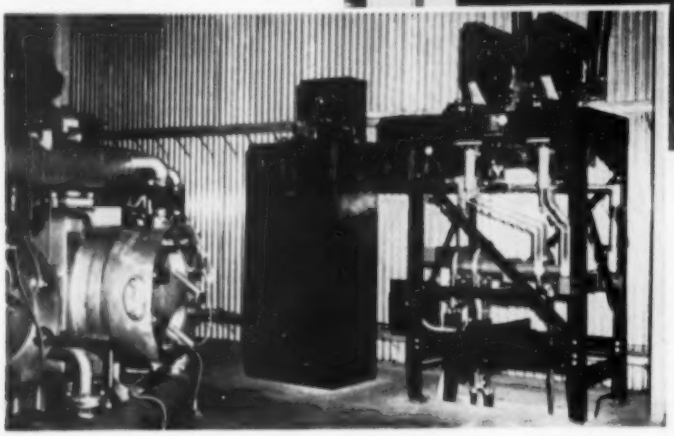


Fig. 3. (Left) The generator switchgear. Bus and cables are of aluminum

Fig. 4. View showing two power houses and part of the 4000-v auxiliary power distribution system, using aluminum towers

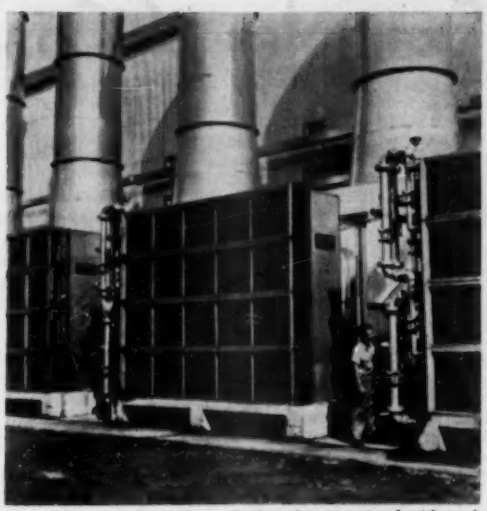


Fig. 5. Close-up of the large fluid coolers associated with each engine to cool jacket water and lubricating oil

blowers supply air at the rate of 7000 cfm.

The axial flow type, generator cooling air fan is driven by a 7½ hp motor. The fan supplies air at the rate of 12,000 cfm. Along the wall behind each generator are the high speed, generator switch gear, generator control and starting equipment.

Combination oil and water, engine coolers were built by The Trane Co. of LaCrosse, Wisconsin. Heat exchangers for the system are approximately 15 by 11½ by 3 ft in size. The exchangers are all-aluminum in construction except for cast iron headers. Alclad aluminum alloy 3S is used for both tubing and fin stock. The tubes are arranged in banks of three with the water tubes in front of the oil tubes.

The tubes and vertical fins are joined mechanically. Each exchanger consists of four sections, which are independent of one another except for connection to a common manifold. Individual tubes may be cleaned or cut out of the system without interfering with the operation of the whole exchanger.

An 84 in. diameter heat exchanger fan, having six adjustable blades, is driven by a 2 speed, 25 hp motor. Oil and water circulating pumps are driven by a common 15 hp motor.

Each engine room has forty building air washing units. These all-aluminum units have housings 14 by 5 by 5 ft in size. Each unit, containing thirty all-aluminum washer cells, has an air capacity of 35,000 cfm. Water is sprayed through the unit at a rate of 125 gpm.

Sixty cycle, 4000 v, alternating current is produced by four 667 v d-c motor driven generator sets. This power is for general use. There is also a 250 v, 250 kw generator on each set which provides power for cranes throughout the works.

Each engine-generator unit has its own stack, which handles engine exhaust, generator cooling air, and the air from the heat exchanger. 7½ ft diameter stacks, having an over-all height of 50 ft, were made from ⅛ in. aluminum sheet. The all-riveted stacks were fabricated on the job.

Practically all electrical conductors in the works are of aluminum. Approximately 5½ million pounds of aluminum bus conductor alone was used. The bus is arranged in three 5000 ft circuits each including one powerhouse and one pot line. The bus joints were made largely by the inert gas shielded arc method of welding, and a complete welding shop was set up on the site for this purpose. The main bus consists of 22 aluminum bars, each having a cross section of ¾ x 10 in.

Aluminum wire, cable and conduit were also used extensively. Because of their resistance to atmospheric corrosion, aluminum towers and substations were used for the 4000 v, auxiliary power distribution system.

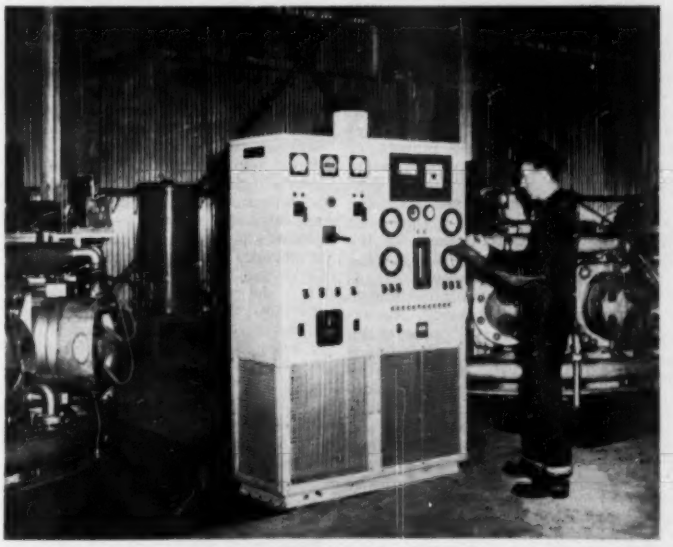


Fig. 6. Individual engine control panel containing both indicating and engine protective equipment

Examples of Condensate Contamination

This article describes four interesting cases of condensate contamination and how they were corrected. All examples are from paper mills but of course, similar conditions could occur in other industries, particularly those in which chemicals are used. As pointed out, these cases can occur quite unexpectedly and unless engineers make a practice of systemmatically checking certain trouble spots serious loss of production may ensue

By J. N. WELSH Director of Engineering Service, Hall Laboratories, Inc.

IT IS NOT SO many years ago that oil contamination of condensate was a major problem in paper mills. Reciprocating engines were used extensively for driving generators and paper machines, with the oily exhaust steam being condensed in the paper machines and returned to the boilers. Also, reciprocating feed pumps were commonly used, exhausting oily steam to the feedwater heaters. Efforts were made to remove oil from the steam with mechanical separators, and from the paper machine condensate and boiler feedwater with towel filters and by coagulation and filtration. True, because of oil film on the internal surfaces of condensate piping, condensate return line corrosion was not the problem it is today with pure steam. However, there frequently was trouble in the boilers, oily deposits causing overheating and failure of tubes, and saponifiable compounding materials in the oil causing difficulty with foaming and carry-over of boiler water in the steam.

Many changes have taken place. In the modern paper mill, turbogenerators are used for generation of electrical power, paper machines are driven by electric motors or steam turbines instead of reciprocating engines, and centrifugal feed pumps have largely replaced the reciprocating pumps of yesteryear. The turbine exhaust used in the dryers, heat exchangers, heating systems, feedwater heaters, etc., is free from oil, and troubles due to oil have largely disappeared. Nevertheless, there are still some weak points in the systems where troublesome contamination of different character can occur, and in many instances the source of contamination is not immediately apparent, location requiring appreciable time and effort. Because such cases will be of interest to all paper mill engineers and chemists, several recent examples of what can happen will be described.

One day last winter, at a paper mill in Pennsylvania, the water in all three Heine, 140 psig pressure boilers began to foam severely. The engineer did the right thing since he immediately stopped feeding phosphate and alkali chemicals to the boiler water and began to blow down the boilers very heavily. These moves permitted the plant to operate without too much difficulty, but they did not get at the root of the trouble, and naturally set up conditions conducive to scale formation in the boilers.

When one of our field engineers arrived at the plant four days later on a routine service visit, he found that the plant engineer had begun to reduce the heavy blowdown, although not yet having located the source of the difficulty and not venturing to resume the feeding of chemicals. Boiler-water samples foamed when shaken, and when freshly drawn, contained material which had the appearance of soap curds. There was no positive evidence of oil contamination of the boiler water, and spot samples of condensate from various sources failed to give a clue as to the source of the contaminant which was producing the difficulty in the boilers.

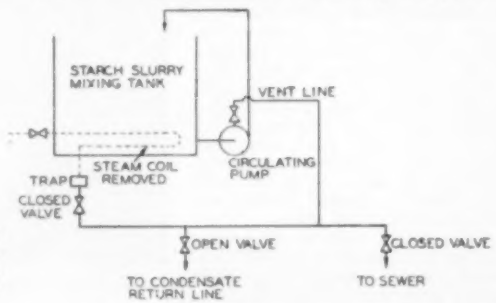
Our engineer immediately collected samples of feedwater and boiler water for determination of the extent of contamination, and for identification of the material having the appearance of soap curds which presumably was the contaminating material. Quick diagnosis of the problem and location of the source of contamination were essential to insure safe and continuous operation of the boilers.

Analyses of these samples showed the feedwater to contain almost 30 ppm of ether extractable material (acidified sample), and the boiler water to contain more than 300 ppm (Table I). The residues from the other extractions were not oily in nature, but were light in color, hard when cold, and soft when warm. When heated, they gave off an aromatic odor. The physical nature of the material suggested rosin, and this composition was confirmed chemically.

Armed with this information, our service engineer investigated the rosin cooking and storage tanks. Although the steam coil in the size storage tank could not be examined since the tank had just been filled with 15,000 gallons of rosin size, condensate samples from the heating coil showed definite evidence of heavy rosin contamination. The source of contamination was thus definitely located. Repair of the steam coil was not immediately possible, but it was a simple matter to discharge the condensate to waste until the size tank was empty.

Starch-Size Contamination

About two years ago, at a large paper mill in Virginia, the water in the 425 psig boilers suddenly turned black and all alkalinity disappeared.



Piping arrangement which resulted in introduction of starch slurry to a condensate return line

Also, the water showed a tendency to foam. The only clue to the cause of the trouble was the simultaneous appearance of some white suspended material in the feedwater. Naturally, the plant engineers and chemists were considerably perturbed, and since the offending material was evidently organic in character, they immediately started checking condensate from various points to locate the source of the contaminating material. The search was fruitless and when the condition cleared up in a day or two everyone breathed easier.

The feeling of security was short-lived. It was a matter of only a day or two until contamination recurred. A considerably worried chief chemist called us for help, and after assuring him that we would get a field engineer on the job, we told him the symptoms resembled those of sugar contamination. The possibility of sugar getting into the boiler feedwater in a paper mill seemed far-fetched, so no immediate search was contemplated for this type of contaminant. Rather, other possibilities were discussed, including inleakage of raw river water contaminated with black liquor, and direct black liquor contamination of condensate. The latter was ruled out, however, since black liquor would increase, rather than decrease, boiler-water alkalinity.

White Powder Enters the Picture

When our field engineer got to the plant he could find no evidence of inleakage of raw river water containing black liquor, and immediately checked the condensate from the various departments of the plant, not finding any to be seriously contaminated. In the meantime, we had considered a number of possible sources of contamination and wired our field engineer to check the rosin cookers for possible leakage of steam coils. He did this at once, but found nothing wrong, and was about to walk out of the size preparation department when he noticed a man dumping sacks of white powder into a large tank. Investigation quickened his interest, since he found the white material to be beater starch, but the plant men accompanying him felt that the starch could not get into the condensate because the steam coil had been removed from the tank.

Not being satisfied that it was impossible for the starch to get into the condensate, our engineer investigated further and found a peculiar piping arrangement. The starch-slurry circulating pump was vented into a sewer line, one branch of which led to piping on the discharge side of a steam trap which had been taken out of service when the steam coil was removed form the starch dissolving tank (Fig. 1). From this unused condensate piping the starch slurry flowed into a larger line carrying condensate back to the boiler house.

Testing the white suspended matter in the boiler feedwater with iodine confirmed that the contaminating material was starch, and elimination of contamination was quickly and easily accomplished by simply closing one valve and opening another.

After the source of contamination was discovered, it was found that there were two lines carrying condensate from the paper-machine area to the boiler house, and all samples from this area checked at the boiler house had been collected from the uncontaminated line. This accounted for the failure to find any contaminated condensate prior to investigation of the starch dissolving tank. It should also be noted that our original suggestion of sugar contamination was not so far-fetched as it seemed at the time, because beater starch is partially converted with acid, and probably contains glucose and dextrins as well as starch.

Fuel-Oil Contamination

Late in 1948, a paperboard mill in California changed from gas to oil as fuel for the 435 psig, 90,000 lb per hour boilers. After approximately two months' operation with the new fuel, oil was detected in the boiler water and in condensate from a condensing turbine. Leaking heating coils in the fuel-oil tanks were responsible, and contamination was halted immediately by wasting condensate from the coils.

In this particular case, the source of condensate contamination was easily and promptly located. Nevertheless, there was considerable concern about how long the oil leakage had been going on and about what damage had been done, or might result later, in the boilers. Since the main danger was tube failures because of formation of oily deposits, and no evidence of distress in the boilers had been noted up to the time of discovery of oil contamination, it was reasonable to expect continued satisfactory operation with the oily condensate being discharged to waste. The recommendations made to hasten removal of oil were to blow down the boilers heavily, and temporarily to maintain relatively high alkalinity in the boiler water. It was also recommended that load on the boilers be kept as light as possible until there was opportunity to take at least one out of service for inspection.

Luckily there was no accident during the two months that passed before a boiler could be spared for internal examination. Asphaltic deposit up to one-half inch in thickness was found in the mud drum, and the main blow-off connection was plugged with this material. Visible portions of boiler tubes appeared to be fairly clean, but one water-wall tube was blistered, and as a precautionary measure all tubes were turbined. Prompt and effective action by the plant personnel had prevented what might have been serious boiler damage and plant shutdown.

Waste-Water Contamination

A Michigan paper manufacturing plant uses lake water, treated by sodium-hydrogen base exchange, as make-up for 600 and 165 psig boilers. Phosphate is used in the boilers to take care of the residual calcium in the make-up water, and normally the amount required is relatively small since hardness of the treated water is quite low.

Last summer the plant experienced a temporarily inexplicable increase in phosphate consumption. Testing of condensate and water samples from the concrete clear well where condensate and treated make-up water are mixed gave no immediate indication of the source of the abnormally large amount of hardness which was getting to the boilers. For several weeks there was no change for the better, and periodic searches for the source of the difficulty proved futile.

One day water conditions became more upset than usual, enough so that action could not be delayed. Investigation revealed a lower than usual water level in the clear well and definite contamination of the clear-well water with hard water. Here was the answer to the persistent and finally serious problem. The concrete clear well was cracked. An adjacent sewer carrying backwash from the raw-water filters, and other waste water was broken. Result, contamination of the clear-well water with hard waste water only when water level in the clear well dropped below the level of the hard water outside.

Conclusion

As has been demonstrated, the dangerous blow of condensate contamination can strike suddenly and unexpectedly. No engineer can assume that it will not happen in his plant nor can he always immediately put his finger on the location when it does occur. He can, however, minimize the possibility of difficulty by periodically checking potential trouble spots such as size-tank heating coils, digester heat exchangers, fuel-oil heaters, condensers, etc. Such vigilance should pay dividends, since a major boiler shutdown, and quite possibly concomitant loss of production, can be inordinately expensive.

Giving analysis of boiler water showing high concentration of organic matter due to rosin contamination of condensate

Table	ppm.
Hydroxide (OH)	58
Sulfate (SO_4)	875
Chloride (Cl)	70
Nitrate (NO_3)	125
Silica (SiO_2)	15
Hardness ($CaCO_3$)	50
Total Solids	2160
Organic (by ether extraction)	305

The FLUX ALGEBRA

A New Method of Calculating

HEAT TRANSFER

The calculation of heat exchange by radiation is one of the most involved and complex in the entire field of thermal engineering. This article by Mr. Ordinanz introduces American engineers to a new and rather original method that reduces all calculations to elementary arithmetic. This mehod has been used in Europe but little about it has appeared in English technical literature

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THE EXCHANGE OF HEAT between bodies of different temperature results from contact or radiation. While there is plenty of data available to calculate heat exchange by contact (involving conduction and convection) the available data for the case of radiation is far less plentiful. The basic laws of heat radiation have been determined by the investigations of Boltzmann, Kirchhoff and others, but the actual calculation by ordinary methods involves the use of extremely complex mathematical formulae. For example, referring to the conditions set forth in Fig. 1, if

T_1, T_2	is the absolute temperature of two bodies I and II in deg. K
C_1, C_2	the coefficients of radiation of the two bodies in Btu per sq. ft. per hr. per deg. K
$C_s = 1.83$	the radiation constant of the absolutely black body
dF_1, dF_2	the surface elements of the two bodies in the points 0_1 and 0_2
ω_1, ω_2	the angle between the connecting line $0_1 0_2$ and perpendicular to the surface elements dF_1 and dF_2
r	the distance $0_1 0_2$
$dQ_{1\to 2}$, $dQ_{2\to 1}$	the quantities of heat radiated from dF_1 to dF_2, resp. dF_2 to dF_1
$dQ_{1\to 2}$	the quantity of heat exchanged between dF_1 and dF_2 by radiation, that is the arithmetical sum of $dQ_{1\to 2}$ and $dQ_{2\to 1}$

we have, according to the laws of heat radiation (Stefan-Boltzmann's law, Lambert's law, etc.)

$$dQ_{1\to 2} = \frac{C_1}{\pi}\left(\frac{T_1}{100}\right)^4 \frac{\cos\omega_1 \cdot \cos\omega_2}{r^2}\, dF_1 \cdot dF_2$$

With real bodies, this quantity of heat is only partly absorbed by dF_2, the remainder being reflected into space. Only a part of this reflected heat, however, falls back to dF_1. Of this again, only a part is absorbed, the remainder being reflected, and so on. dF_1 on the contrary receives from dF_2 the quantity of heat

$$dQ_{2\to 1} = \frac{C_2}{\pi} \cdot \left(\frac{T_2}{100}\right)^4 \cdot \frac{\cos\omega_1 \cdot \cos\omega_2}{r^2} \cdot dF_1 \cdot dF_2$$

from which dF_1 absorbs only a part, the remainder being reflected into space from which only a part falls back to dF_2, and so on.

To calculate even a few such to and fro interchanges involves considerable mathematical difficulty and it becomes imperative

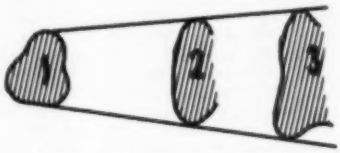


Fig. 2. The radiation from body 1 to body 2 and body 3 is equal when solid angle and situation in space are equal

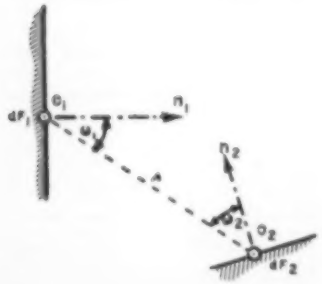


Fig. 1. Diagram showing quantities involved in heat transfer calculations

to make certain simplifying assumptions. In the case of bodies with such a high absorbing power that the radiation may practically be considered completely absorbed after the initial incidence, Nusselt[1] gives the heat exchange between dF_1 and dF_2, sufficiently accurate, as

$$dQ_{1\to 2} = \frac{C_1}{\pi} \cdot \frac{C_2}{C_s} \cdot \left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right] \frac{\cos\omega_1 \cdot \cos\omega_2}{r^2}\, dF_1 \cdot dF_2$$

and the total of heat exchange by radiation for the complete surface resolving to

$$Q_{1\to 2} = \frac{C_1}{\pi} \cdot \frac{C_2}{C_s} \cdot \left[\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_2}{100}\right)^4\right] \iint_{F_1 F_2} \frac{\cos\omega_1 \cdot \cos\omega_2}{r^2} \cdot dF_1 \cdot dF_2$$

Despite the simplifying assumption, the determination of this double integral, known as the angle coefficient, or angle ratio, makes difficulties also, even for relatively simple geometrical configurations. In practice various graphical approximate methods are used, methods such as formulated by Nusselt[2] Hottel[3] and Seibert[4].

Because of these difficulties with conventional methods of treatment, a recent method of attack involving what is known as *flux algebra* should be of interest to engineers concerned with heat transfer problems. The use of this flux algebra reduces all operations to simple arithmetic ones.

Let us start with the two fundamental notions with which the flux algebra operates. They are the previously mentioned *angle coefficient* and the so-called *effective surface*.

The angle coefficient or angle ratio of two bodies, I and II, is the share of radiation received by body II from body I in relation to the total radiation of body I. If Q_1 is the total radiation of body I, and $Q_{1\to 2}$ the share received by body II, then the angle coefficient is

$$\varphi_{1-2} = \frac{Q_{1\to 2}}{Q_1}$$

From this, it is evident that angle coefficients are always < 1. Only in the case of two spherical bodies, one inside the other will the angle coefficient of the radiation received by the outer sphere from the inner one be equal to 1.

We can suppose that this part φ_{1-2} of the radiation of body I that is expressed by the angle coefficient, and is received by body II, is radiated by a corresponding part of the radiating surface of body I. This part of the surface is called the *effective surface* of body I in relation to body II. It has the same numerical value as the angle coefficient. If E is the specific radiation of the surface unit of the considered body I, and F_1 its surface, the total radiation will be $Q_1 = E \cdot F_1$. By analogy we have $Q_{1\to 2} = E \cdot H_{1-2}$ as the product of the specific radiation and a theoretical surface that is the same share of F_1 as $Q_{1\to 2}$ of Q_1. Consequently, we will have:

$$Q_{1\to 2} = \varphi_{1-2} \cdot Q_1 \text{ and } H_{1-2} = \varphi_{1-2} \cdot F_1$$

The term effective surface is a translation of the corresponding German and Russian terms. It may be regarded as an expedient in the absence of a better term.

The notions of angle coefficient and effective surface are bound to the existence of a pair of bodies. As has been shown their numerical values are the same but the angle coefficient is dimensionless whereas the effective surface is an area. As to the written symbols, radiated quantities, having so to speak, vectorial character, get indices with arrows; e.g. $Q_{1\to 2}$, contrary to the opposite directed radiation flux $Q_{2\to 1}$, written without an arrow, being in effect the arithmetical sum. For the quantities H and φ no arrows are necessary.

The flux algebra as a whole is based on the following five fundamental rules:

1. The radiation of a body to various other bodies located one behind another is—independent of the distances—the same, if only the angle, (solid angle) the location subtended, and the angular position in space are the same. See Fig. 2.
The mathematical form of this rule is

$$Q_{1-2} = \varphi_{1-2} \cdot F_1 \cdot C_0 \left(\frac{T_1}{100}\right)^4 = Q_{1-3} = \varphi_{1-3} \cdot F_1 \cdot C_0 \left(\frac{T_1}{100}\right)^4.$$

It follows that:

$$\varphi_{1-2} + \varphi_{1-3} \text{ and } H_{1-2} = H_{1-3}$$

2. The total radiation exchange between bodies is the arithmetical sum of the radiation exchanged between the partial surfaces of the bodies.

For example, if body I consists of the partial surfaces 1a and 1b but body II of the partial surfaces 2a and 2b, then

$$Q_{1\to 2} = Q_{1a\to 2b} + Q_{1a\to 2b} + Q_{1b\to 2a} + Q_{1b\to 2b}$$

from which it follows, that

$$H_{1-2} = H_{1a-2a} + H_{1a-2b} + H_{1b-2a} + H_{1b-2b}$$

3. If there is an athermos medium (screen) between two bodies, we find

$$Q_{1-2} = \text{nil}$$

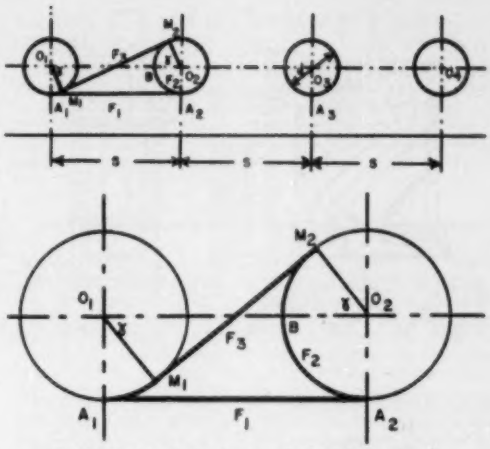


Fig. 3. Heat exchange between boiler tubes and wall

Thus, it follows, that $H_{1-2} =$ nil, and $\varphi_{1-2} =$ nil.

It needs no explanation that in the case of a convex body self-radiation is not possible and that for such a body

$$Q_{1-1} = 0,\ H_{1-1} = 0 \text{ and } \varphi_{1-1} = 0$$

For bodies with concave surfaces self-radiation is possible.

4. For a radiating body 1 that is surrounded by $(m-1)$ bodies,

$$\sum_{i=1}^{i=m} Q_{1-i} = F_1 \cdot C_0 \cdot \left(\frac{T_1}{100}\right)^4$$

and

$$\sum_{i=1}^{i=m} H_{1-i} = F_1 \quad \text{and} \quad \sum_{i=1}^{i=m} \varphi_{1-i} = 1$$

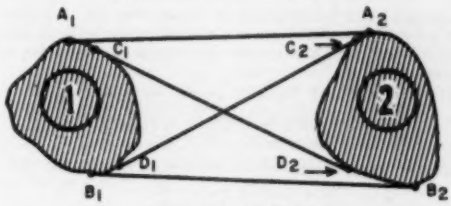


Fig. 4. The string rule

In the same manner for a geometrically closed system of n bodies a series of n equations can be put, as follows:

$$\sum_{i=1}^{i=n} H_{k-i} = F_k, \qquad \text{where } k = 1,2,3 \ldots\ldots\ldots\ldots n$$

$$\sum_{i=1}^{i=n} \varphi_{k-i} = 1, \qquad \text{where } k = 1,2,3 \ldots\ldots\ldots\ldots n$$

5. For black bodies of equal temperature the reciprocal radiation is equal, independent of the situation in space and the medium that is between the bodies, so that

$$Q_{1\to 2} = Q_{2\to 1}$$

In consequence $H_{1-2} = H_{2-1}$ or $F_1 \cdot \varphi_{1-2} = F_2 \cdot \varphi_{2-1}$

An example will show how simple calculations become by means of these rules of the flux algebra. In this example the heat ex-

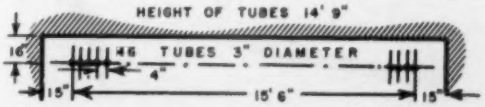


Fig. 5. Outline of numerical example

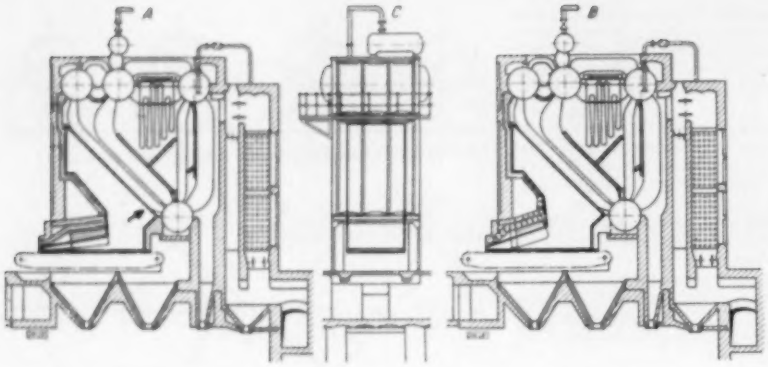


Fig. 6. Diagrams showing changes to boiler furnace

change by radiation between a row of boiler tubes and the parallel wall of the flue will be calculated by means of the new method. All following considerations refer to Fig. 3 showing the wall and several boiler tubes.

According to rule 1 we consider, instead of the wall, a parallel one that *touches* the tubes. It follows from the figure and Rule 3 that the radiation of a single tube falls only on the part $A_1A_2 = 2\,A_1A_0$ of the wall. For the geometrically closed system of lines $A_1A_2 = F_1$, $A_2\,M_2 = F_2$ and $A_1M_1 + M_1M_2 = F_3$ (to be exact these are surfaces and have to be multiplied by the height of the wall and tubes) we can write, according to rule 4, the three equations:

$$\left.\begin{aligned} H_{1-1} + H_{1-2} + H_{1-3} &= F_1 \\ H_{2-1} + H_{2-2} + H_{2-3} &= F_2 \\ H_{3-1} + H_{3-2} + H_{3-3} &= F_3 \end{aligned}\right\} \quad \ldots\ldots\ldots \text{(a)}$$

where F_3 has to be regarded as a fictitious auxiliary surface. As none of these surfaces have concave forms, according to rule 3 we have

$$H_{1-1} = 0;\ H_{2-2} = 0;\ H_{3-3} = 0.$$

Assuming equal temperatures of the surfaces and that there are black bodies involved (the real deviations can subsequently be corrected by means of coefficients), we can put according to Rule 5:

$$H_{1-2} = H_{2-1};\ H_{1-3} = H_{3-1};\ H_{2-3} = H_{3-2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(b)}$$

Thus the sum of the three equations of (a) will be

$$H_{1-2} + H_{1-3} + H_{2-3} = \tfrac{1}{2}\,(F_1 + F_2 + F_3) \quad \ldots\ldots\ldots\ldots\ldots \text{(c)}$$

Subtracting from (c) each of the three equations (a), we get

$$\begin{aligned} H_{1-2} &= \tfrac{1}{2}(F_1 + F_2 - F_3) \\ H_{2-3} &= \tfrac{1}{2}(F_2 + F_3 - F_1) \\ H_{1-3} &= \tfrac{1}{2}(F_1 + F_3 - F_2) \end{aligned}$$

The effective surface between wall and single tube being $H_{w-1} = H_{1-w} = 2H_{1-2}$ resolves to $F_1 + F_2 - F_3$ but the angle coefficients

$$\text{from tube to wall } \varphi_{1-w} = \frac{H_{1-2}}{F_1} = \frac{F_1 + F_2 - F_3}{F_1}$$

$$\text{from wall to tube } \varphi_{w-1} = \frac{H_{1-2}}{F_w} = \frac{F_1 + F_2 - F_3}{F_1}$$

If s is the pitch of tubes, d their diameter, and α the angle in the point of contact, we obtain:

$$A_1A_2 = s;\quad A_2BM_2 = (\pi/2 + \alpha)\frac{d}{2};$$

$$A_1M_1F_3M_2 = A_1M_1 + 2M_1F_3 = (\pi/2 - \alpha)\cdot\frac{d}{2} + d\,\tan\alpha \quad \text{from}$$

which results:

$H_{1-w} = H_{w-1} = [s - (\tan\alpha - \alpha)\cdot d] \cdot$ Height of system.

From the triangle 0_1M_1E in Fig. 3 it follows that

$$\alpha = \text{arc tan}\,\sqrt{\left(\frac{s}{d}\right)^2 - 1}$$

and we obtain

$$H_{1-w} = H_{w-1} = \left[s - d\cdot\sqrt{\left(\frac{s}{d}\right)^2 - 1} + d\cdot \text{arc tan}\,\sqrt{\left(\frac{s}{d}\right)^2 - 1}\right].$$

the height of the system

Multiplying the value for H_{w-1} by the number of tubes n, the corresponding radiation coefficient C that will include all de-facto deviations from the ideal case of an absolute black body, and the temperature values (in deg. K), we will find the heat radiation exchange to be

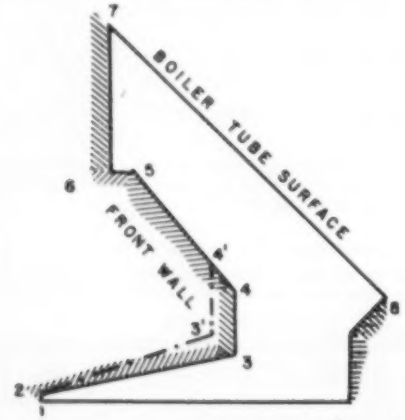


Fig. 7. Schematic outline of firebox contours of boiler. Before rebuilding (234567) After rebuilding (23'4'567)

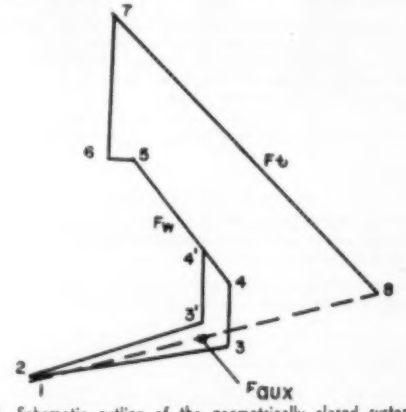


Fig. 8. Schematic outline of the geometrically closed system of front wall F_w (1234567 with respect to 123'4'567) boiler tubes F_1 (78) and auxiliary surface F_{aux} (81)

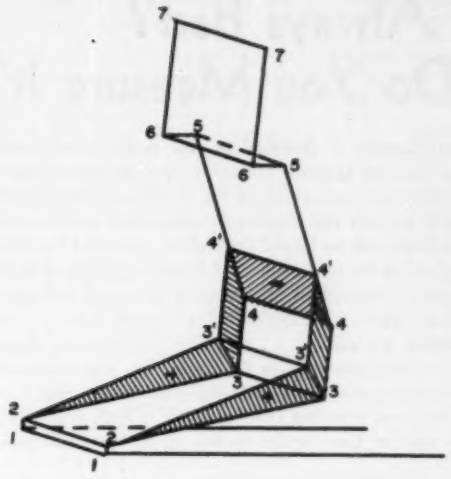


Fig. 9. Schematic outline of wall surface changes by rebuilding boiler
— Surface = Surface diminution of front wall
+ Surface = Surface increase of side walls

$$Q = H_{w-t} \cdot n \cdot C \cdot \left(\frac{T}{100}\right)^4 \text{ resp. } H_{w-t} \cdot n \cdot C \left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T_t}{100}\right)^4\right]$$

For rapid and approximate calculations an empirical formula, the so-called "string-rule" can be used. Suppose (Fig. 4) an elastic string is wound round two radiation exchanging bodies so that it completely fits the contours of the bodies. The effective radiation surface is then equal to half the sum of the so-called inner strings minus half the sum of the outer strings, that is

$$H_{1-2} = H_{2-1} = \frac{A_1C_1D_1B_2 + B_1D_1C_2A_2}{2} - \frac{A_1A_2 + B_1B_2}{2}$$

By means of the string-rule the result of the above example could have been obtained in a few minutes.

Numerical Example

Find the amount of heat radiated to the first row of boiler tubes in a vertical tube boiler from the nearby wall. There are 46 tubes, each of 3 in. dia., spaced with 4 in. pitch according to Fig. 5. The temperature of the wall is 1312 deg. F (= 984 deg. K), of the tubes 552 deg. F (= 562 deg. K). The radiation coefficients are for the wall (chamotte bricks) $C_1 = 1.37$, for the tubes $C_2 = 1.74$ Btu per sq. ft. per hr. per (deg. K)^4.

Solution: (a) Effective surface between wall and a single tube

$$H_{w-t} = \left[s - d\sqrt{\left(\frac{s}{d}\right)^2 - 1} + d \cdot \text{arc tan } \sqrt{\left(\frac{s}{d}\right)^2 - 1}\right] \cdot \text{Height of tube}$$

From the given dimensions $\frac{s}{d} = \frac{4}{3}$,

therefore $\sqrt{\left(\frac{4}{3}\right)^2 - 1} = 0.877$

and arc tan 0.877 = 0.72. H_{w-t} = 3.529 in. × 14 ft. 9 in. = 4.34 sq. ft.

(b) The total amount of radiated heat results to

$$Q = H_{w-t} \cdot n \cdot C \cdot \left[\left(\frac{T_w}{100}\right)^4 - \left(\frac{T_w}{100}\right)^4\right]$$

where n is 46 and $C = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} - \frac{1}{C_s}} = 1.33$. As a consequence we obtain $Q = 4.34 \times 46 \times 1.33\ [(9.84)^4 - (5.62)^4] = 2{,}225{,}000$ Btu per hr.

Thus, it will be seen, flux algebra provides a simple method for calculating the heat exchange by radiation but with a single restriction; it is limited to radiation between *solid* bodies. In modern steam boiler practice, however, we are concerned largely with heat radiation from the *gases* of combustion, and readers may ask what practical value the flux algebra has in dealing with boilers.

The Value of Flux Algebra in Heat Transfer Calculations

In answering this question it must be pointed out that it would be taking too narrow a view of the method if we consider only the steam boiler field. It should be considered in relation to the whole field of thermal engineering, including the design of the manifold equipment involved in chemical processing plants, in textile plants, metallurgy and industrial furnaces. In all of these branches of the field problems in heat radiation occur involving heat exchange between solid bodies and the customary methods of calculation will be found very complicated—twice as difficult to the designer having little facility with higher mathematics. Here the flux algebra will be, not only the simplest method, but also a very practical instrument for making quick estimates. An example taken from the literature may serve to illustrate this to good advantage.

In modern steam boilers the load of the heating surfaces has reached high performance values. This has, no doubt, led to the considerable increase in boiler economy steam engineering may be proud of. At the same time, however, the difficulties in boiler maintenance have increased considerably. Many a boiler engineer has had his troubles with tube damages due to excessive temperature at single points, and the solution of such troubles is often more of a puzzle than to the systematic work of an engineer.

The supporting literature is not a large one. Between the few articles that have been published there is also a German study, entitled, "die Waermeaufnahme der bestrahlten Kesselheizflaeche" (The Heat Reception by the Radiated Boiler Heating Surface) by O. Seibert[4], dealing with the influences of heat radiation from firebox walls to tubes. In particular, the case of a vertical tube steam boiler, shown in Fig. 6, is analyzed. From the moment of being put into service, tube damages due to excessive temperatures in the lower parts of the water tubes (as marked in the sketch, Fig. 6) were considerable. The manufacturers thought that shortening the length of the ignition vault (execution B instead of A) will remove the troubles. Their consideration was "less wall surface less heat." It was a complete failure; furthermore, after the changes were made damages were as bad as before.

In his study Seibert calculated heat radiation between the single parts of the heating surfaces by developing a rather complicated mathematical method, and succeeded proving that the result of rebuilding the boiler in the way described could not be but negative. As a scientific performance Seibert's study is an excellent one; not so much from the practical point of view. It needed about 120 pages, half for the theoretical foundation and its application to a given case, as to give even an approximate result.

In such a case the flux algebra is the ideal instrument for a quick, mental estimate. Superposing fire-box contours before and after rebuilding upon one another, as done in Fig. 7, shows that only a part of the front wall contour has been changed. The surfaces to be considered are, therefore, the frontwall, F_w and the boiler tubes. These form together with an auxiliary imagined surface, F_{aux}, a geometrically closed system, in which—according to the string rule—the effective surface from wall to tubes is

$$H_{w-t} = \frac{1}{2}\left(F_w + F_t - F_{aux}\right)$$

Offhand, this shows that shortening the front wall will reduce its surface only by several per cent, and by no means can this essentially improve the situation. Add to this that front wall reduction is more than compensated by side wall enlargement, as shown in Fig. 9, and the whole matter has taken about five minutes. Such cases make it worthwhile to be acquainted with flux algebra.

Moisture in Coal—Is It Always Bad? How Do You Measure It?

By A. F. RIEBER

This article is a further discussion of Question No. 457, to which two answers were published in The Practical Engineer section, May 1950 issue, page 92 . . . The present author reviews and contrasts the troubles in handling coal caused by moisture and explains the benefits to combustion resulting from proper tempering of coal for use on forced draft chain grate and underfeed stokers . . . He then gives details of a method of measuring moisture in coal by a moisture meter used in one of his production departments but seldom seen in industrial power plants . . . Details of a second semi-automatic moisture measuring device are added . . . Author is in processing department of large manufacturing company in St. Louis, was previously chief operating engineer, conducts power plant engineering adult education classes in a technical high school, was a marine chief engineer in both World Wars and at present holds rank of Commander in the U. S. Maritime Service

WATER HAS absolutely no heating value in a furnace; in fact, it is considered highly detrimental in combination with any fuel, for the heat necessary to convert water into steam is absorbed from the fuel and lost up the stack along with the products of combustion. Moisture in coal is a veritable bugaboo in plants using pulverized coal. It stops up the chutes, cements together and arches over in the bunker and must be dried before going to the mills. So what follows does not apply to pulverized-fuel jobs and is applicable only to stokers with forced draft of the chain grate and underfeed type and has no practical application to even the spreader type of stoker.

Industrial coal, properly washed to remove all the clay and noncombustible matter, is free flowing just like pure sand or gravel, for it is only the clay or earthy matter that cements it when it is wet. However, all producers of industrial coals are not too particular about removing all the clay and very little of the moisture, unless a high premium is paid for this service. So, on short hauls, the coal is very often completely saturated with moisture and in freezing weather, the moisture will freeze in transportation unless calcium chloride is added to lower the freezing temperature of the water in the coal.

Yet it is a fact that all varieties of screenings from bituminous coals burn better and produce more pounds of steam per pound of fuel when the coal screenings are thoroughly saturated with water—that is, tempered. This applies particularly to the coals of the mid-continent group and includes Indiana, Illinois and Western Kentucky coals. The reasoning which follows has been applied to forced draft chain grate and underfeed stokers only.

Discussion of excess moisture in coal has extensive ramifications; therefore it is not the purpose of this article to cover all phases of moisture, but to indicate the advantages of moisture in specific applications and to present a highly practical and efficient method for determining the moisture content of all coals under any conditions.

Why Temper Coal?

Tempering of coal is generally understood by most power engineers, but it may be well to review it for

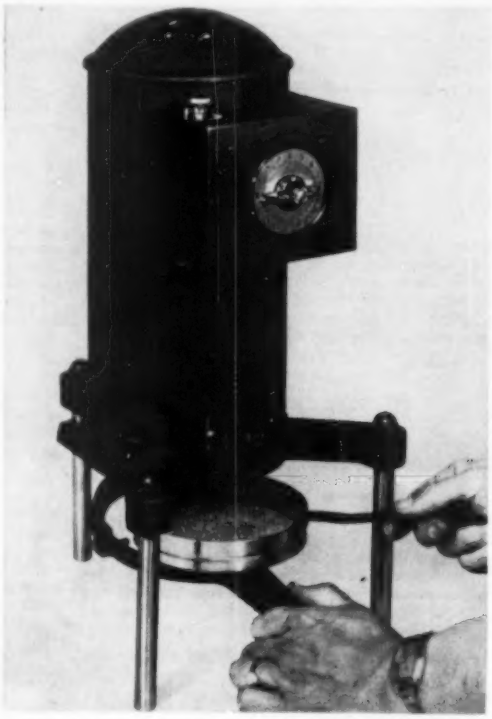


Fig. 1. The Distort Moisture Teller shown here consists of a blower, a heating element, a sample pan and the housing

The blower forces air through an electrically-heated Nichrome grid mounted in a refractory frame and down through the sample pan containing the coal sample. The sample pan has a filter bottom to insure complete ventilation. A thermostat controls the electric current to the heating element grid, thus controlling the air temperature; and a timer controls the drying time.

The sample is weighed quickly before and after being dried. A sliding counterweight is used on the laboratory balance. By using this counterweight in balancing the pan, the percentage of moisture, which is the weight loss, can be ascertained rapidly by moving the rider of the balance on the scale beam.

Accuracy of the determination is claimed to equal that obtained by the oven drying method. Any of the power plant operating personnel can conduct a coal moisture determination by this method, for it does not require a skilled laboratory technician nor a mathematician to calculate results.

The Moisture Teller has been used for measuring moisture in a wide variety of materials in addition to coal, such as sand, tobacco, sugar, salt and the like. Hence, in industrial plants, it may have many important uses in testing products of processes, thus increasing its "load factor" and making it a very economical device.

the benefit of some who may not remember too clearly what is behind it.

In the old days of the old hand-fired furnace with natural draft, very little attention was paid to wetting of coal and the only reason it was done was to allay dust. Of course, hand-fired furnaces usually used mine-run, nut, or egg sizes, rarely using screenings. However, with the introduction of the mechanical stoker with forced draft, steam plants started the use of grades of coal that were formerly thrown away or used for ballast on railroad tracks. With the burning of these cheaper grades of coal, it became imperative that these screenings be tempered with a definite amount of moisture to obtain the combustion efficiency commensurate with economy and good practice. All manufacturers of chain grate stokers realized this, so equipped the stoker hopper with a tempering line, supplied with exhaust steam to add moisture to the coal as it was fed to the grate.

While this method of the use of exhaust steam to supply the moisture was better than none, the best method was to thoroughly saturate the screenings as they were being conveyed to the bunker. Many coal bunkers are equipped with a drag conveyor, so it is a simple matter to arrange a spray over this conveyor for at this point the moving coal is reduced to a thin, narrow stream so the tempering water will strike the greatest amount of surface of the coal. Boiling hot water gives the best results.

As this wetted coal would lie in the bunker for several days, the added moisture would have a chance to penetrate into each small piece before being burned. Actual tests proved that the time required for the coal to become thoroughly tempered was at least 36 hrs from the time of wetting to the time of burning. It was also discovered that to get the best results, the coal should be wetted until the moisture content equaled 12 per cent to 15 per cent.

Today, in the city of St. Louis, practically all steam coals must be washed to conform to city ordinances, so no one adds moisture any more, for the delivered coal usually contains in excess of 15 per cent moisture depending on the size.

First to note the advantages of moisture in coal were the locomotive firemen. Run-of-mine, containing from 40 per cent to 60 per cent of fines, was the usual grade of coal burned in the furnaces of locomotives. The induced draft action of the engine exhaust nozzles in the stack blew practically all the unconsumed fine coal up the stack, developing large holes in the fuel bed, thereby materially reducing the steaming capacity of the locomotive. The firemen readily discovered that turning the hose on the coal pile kept the fine coal in the furnace until burned, they did not have to watch for holes in the fire, and the clinker was softer and easier to handle.

It took stationary plants a long time to wake up to this fact. Many plants burned a specially-sized coal, for which they paid a premium, because they did not recognize that smaller or finer sizes of coal could be burned with equally good results if tempered with moisture to the point of saturation.

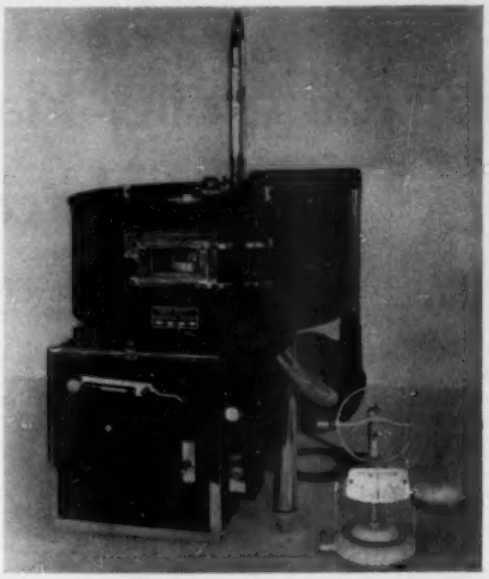


Fig. 2. A Brabender semi-automatic moisture tester

This is a combination warming oven and balance so arranged that weighings may be made without removing the sample from the oven. It is so calibrated that when using 10-gram samples, readings may be taken directly in per cent moisture. The warming oven is electrically heated, with thermostatic control adjustable for temperatures from 85 to 175 C. A small motor blower provides air circulation through the warming chamber during drying process.

This moisture tester, like that of Fig. 1, has been used for some years in determining moisture in grams, food products, powdered materials. Its use for coal moisture determinations was reported as early as 1942 by Rees and Bursack of the Illinois State Geological Survey in *Industrial & Engineering Chemistry*.

Proof of Benefits from Tempering

To prove that tempering of coal improves its burning, a large number of exhaustive tests were conducted, the two comparative and outstanding ones being listed below:

	Test No. 1	*Test No. 2*
Lb coal burned	38,460	36,050
Btu of coal as burned	10,800	10,100
% moisture in coal	8.8	14.6
Lb of steam generated	276,910	209,215
Evaporation		
Lb Steam/Lb Coal	7.2	8.3
% of boiler rating	175	185
% CO_2 by Orsat (average)	11.6	13.5
% combustible in ash	28.5	5.0
Duration of test (hours)	8	8

The grade of coal was Illinois Inner Group from the Mt. Olive district standard 1¼ in. screenings with the percentage of fines below ¾ in., equalling 45 per cent. Increasing the moisture content from 8.8 per cent to 14.6 per cent resulted in an increase of evaporation from 7.2 lb to 8.3 lb, an increase of 14 per cent.

What caused this result is apparent by the increase in combustion efficiency as indicated by the CO_2 and loss of combustible to the ash pit. In the case of Test No. 1, the coal was comparatively dry so the forced draft through the grates blasted holes in the fuel bed by blowing the finer particles of coal into suspension, thus admitting excess air and reducing the CO_2. Also the larger particles of coal did not get enough air, so were dumped into the ash pit unconsumed.

In Test No. 2, the coal was comparatively wet. This additional moisture evidently bonded the finer particles together preventing the blast of the draft from throwing them into suspension and creating holes in the fuel bed. On the other hand, the moisture which had soaked into the larger particles as it flashed into steam cracked these larger pieces into smaller ones, thereby giving them an opportunity to burn uniformly with the finer particles. This action produced an even distribution of the air which greatly improved combustion, as indicated by the improved CO_2. Also the loss of combustible to the ash pit in Test No. 2 was only 18 per cent of the loss in Test No. 1, which is conclusive proof that the performance of the wet coal in the

(Continued on page 106)

Elliott Co. Boiler Plant Built Without Interrupting Service

Two modern spreader stoker-fired, integral furnace boilers rated at 70,000 lb per hr each replace five old units which were installed in the same space

DURING THE war, like many other industrial plants, the Jeannette plant of the Elliott Company got by as best it could with existing power facilities. During this trying period, however, plans were laid for a new, modern boiler plant to be built as soon after the war's end as expedient. One stoker-fired, one oil-fired, and three old hand-fired boilers were to be discarded in favor of a completely new, modern boiler installation. It was planned to retain the existing building, however.

This new plant with only two boilers has a capacity greater than the combined capacity of the five old boilers, and is installed in the same space, with room left over for a compressor room.

Fig. 1. Side view of the boilers. At the left is the continuous blow-down flash tank with blow-down and float valves. At the right, one of the two dual-driven boiler-feed pumps

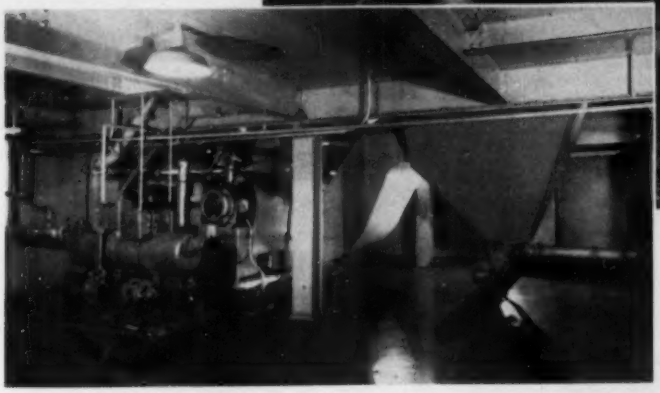
The Elliott boiler plant, in addition to furnishing steam to a turbine-generator which supplies part of the plant's electrical requirements also furnishes steam for the testing of turbines, blowers, steam jet ejectors, and turbochargers. Such testing requires large and unpredictable quantities of steam at irregular intervals.

Obviously, with this type of load and with a full production schedule, it was necessary that full steam generating capacity be maintained during the period of conversion. This requirement was met in the use of an old locomotive from the Pennsylvania Railroad. This locomotive was backed into the boiler house alongside the three old hand-fired boilers where it could easily be taken care of by the firemen. To get better results from the locomotive boiler, the induced draft fan from the first old boiler removed was placed on top of the boiler house and connected to the front end of the locomotive. This was described in a short article in our October 1947 issue.

Views of the new boiler installation are shown in the accompanying photographs. The new boilers are of the integral furnace type each rated at 70,000 lb per hr, generating steam at 650 psi, 825 F. They are fired by spreader stokers burning 1¼-in. crushed coal. The coal is handled by track hopper to the crusher, then through a pan conveyor to an elevator which delivers either to an outside storage tank or

Fig. 2. (Right) A view along the front of the boilers showing the spreader stokers

Fig. 3. (Below) View underneath the boilers



Coincident with the construction of the new boiler plant the test floor was revamped and two new 1360-cfm motor-driven compressors were installed. These units furnish air at 100 psig, which is used throughout the manufacturing plant and foundry.

to the coal bunkers above the boilers. All coal is weighed, all water and steam are metered. Water is treated external to the boiler by the sodium zeolite process and internally with phosphate and caustic soda. The water treatment is checked each eight-hour shift.

Draft is obtained by the use of Thermix stacks and induced-draft fans with a fly-ash precipitator to clean the stack gases. Ashes are handled by a pneumatic system and delivered to a dustless ash hopper with a pug mill for wetting the ashes when they are discharged into trucks for disposal.

Naturally, the new boiler plant is served by considerable Elliott Company equipment. An Elliott spray-type deaerating heater is used and the two centrifugal boiler-feed pumps are dual powered by Elliott motors and turbines. These pumps are normally driven by the induction motors, the water delivered to the boilers being controlled by a three-element feedwater regulator. The turbine drive is used when low pressure steam is needed for heating. Elliott induction motors drive the forced and induced draft fans, as well as the cinder return and overfire air fans. The boilers are equipped with economizers and soot blowers.

While the boilers generate steam at 650 psi, the test floor requires a wide variation of steam conditions. These are obtained by the use of various reducing valves and desuperheating stations.

Fig. 4. (Right) Upper left, Elliott 180,000 lb per hr deaerating feedwater heater. This unit is of the latest design, with no external vent condenser. Upper right, circuit breakers and starting equipment. Below is the sodium zeolite feedwater treating equipment

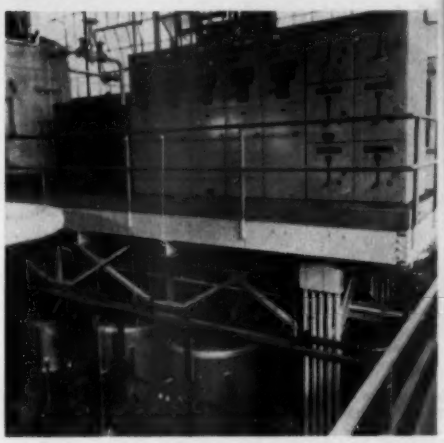
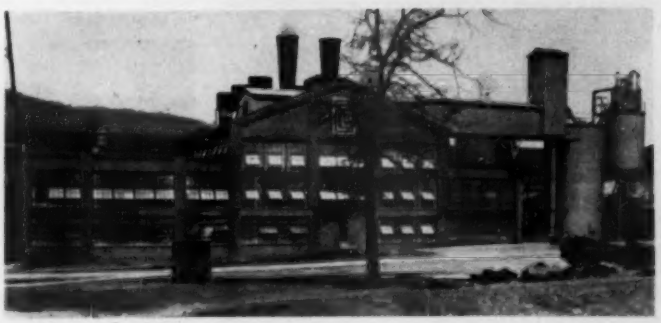


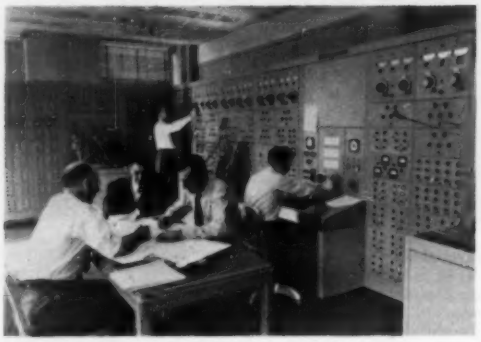
Fig. 5 (Below) Exterior of the Elliott boiler plant



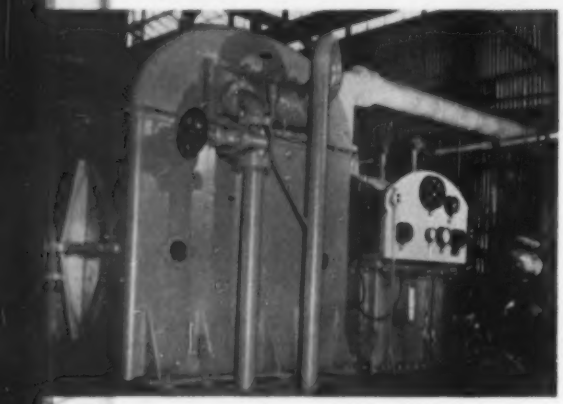
Power Engineering

Loading a 35,000-lb, 42,000/17,500-kva, 13,-800-v, 720 rpm, hydrogen cooled Allis-Chalmers synchronous condenser, with 180-kw exciter for shipment to Bonneville Power Administration

Mile-a-minute wind and freezing water simulate hurricane conditions in this test demonstration put on by General Electric recently to show the protection offered by the construction of its new modified base-ventilated motor. After being subjected to this treatment for 30 minutes at Schenectady Works, the motor was disassembled and its coils, inner air passages, and bearing housings were found dry

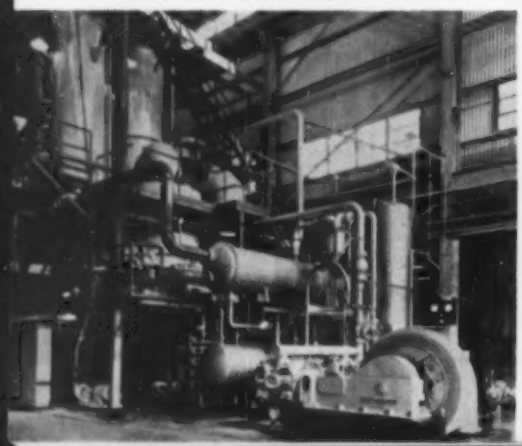


Engineers from the Metropolitan Edison Co., Reading, Pa., recently utilized General Electric's network analyzer in Schenectady to solve a series of network problems. Shown at work on the analyzer are F. S. Fehr of Metropolitan Edison, standing between the network plugboards, and L. K. Kirchmeyer, G-E engineer, seated at the console. At the table are A. R. Deck (left) of Metropolitan Edison, R. B. Hanford, G-E, and D. F. Krug from the utility



Engineer Arthur Bliss adjusting a valve on one of two Navy-type General Electric turbine generators installed in the Saginaw-Manistee Lumber Co., Flagstaff, Arizona. The equipments were the main propulsion generators on a DE-51 class escort vessel, and were converted by the G-E Los Angeles, Calif., Service Shop

At frozen-orange-juice-concentrate plant of Minute Maid Corp. this 500-ton Worthington ammonia refrigeration system maintains orange juice in process always below 75 F



Horse collars for Hungry Horse. These spiral casing sections are part of one of the four 105,000-hp power turbines being built by the Allis-Chalmers Mfg. Co. for the Hungry Horse dampower plant. Over-all width of the entire casing, with all four sections bolted together, will be 40 ft. Four turbines, which will spin four 71,250 kw generators, will harness the South Fork of the Flathead River

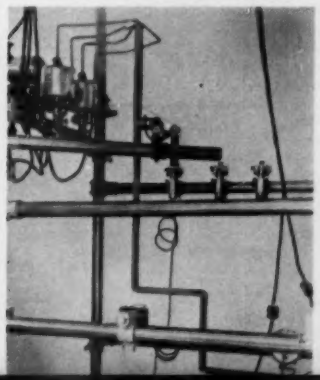
NEWS REEL

Newly-built engineering laboratory designed primarily for audio noise and special temperature tests has been placed in use at Allis-Chalmers Manufacturing Co. plant in Pittsburgh. Auxiliary test equipment delivers 1200 kva, permits standard testing of transformers up to 5000 kva. Two-foot thick walls of the new laboratory are constructed of concrete, concrete block and air pockets, fiber glass and acoustic tile. Ambient noise level is 27 decibels, walls absorbing 99.98 per cent of exterior noise power.

Important milestone in construction of the Bureau of Reclamation's Hungry Horse dam has been passed with placement of the first concrete in the 394-ft-long powerhouse. The photograph shows concrete being placed in the powerhouse area in the foreground with the huge blocks of the dam rising in the background. Also shown are the four 13½ ft diameter penstocks which will carry water from the reservoir to the four 105,000-hp turbines in powerhouse. (Bureau of Reclamation photo)

Steam drum weighing 116 tons, for world's largest boiler arriving at New York Naval Shipyard from Barberton, Ohio, plant of The Babcock & Wilcox Co., prior to movement to Hudson Avenue, Brooklyn, electric generating station of Consolidated Edison Company of New York, Inc. Drum is 60 ft long, 6 ft in diameter

This unique four-pipe main steam line for the new addition to Consolidated Edison's Hudson Avenue Station in Brooklyn, N. Y., is shown here during recent tests on The M. W. Kellogg Co.'s exclusive model piping system flexibility-analyzer. The installation, due for completion the latter part of this year, will operate at 1050 F, and 1500 psi pressure. Due to the unusual amount of steam passing through the main steam line (1,370,000 pounds per hour), it was decided to use the four-pipe construction to feed the 60,000 kw topping turbine. Use of multiple piping instead of a single pipe not only reduced the cost of the installation but also provided for the necessary flexibility



Phosphoric Acid for Cleaning High-Pressure Boilers

IMPORTANT ADVANTAGES in the use of phosphoric acid instead of hydrochloric acid for the cleaning of modern, high-pressure high-heat-input boilers were reported at the semi-annual meeting of the American Society of Mechanical Engineers in St. Louis, Mo., June 22. T. E. Purcell, general superintendent of power stations, and S. F. Whirl, chief chemist, power stations department, Duquesne Light Co., Pittsburgh, Penna., co-authors of a paper at a technical session, said that inhibited phosphoric acid removed rust and mill scale from new boilers and water-formed insoluble deposits from serviced units without the limitations and adverse effects associated with inhibited hydrochloric acid.

Comparison of Two Types

The principal advantage of phosphoric over hydrochloric acid, they said, is that it can be boiled in the unit by direct firing of the boiler with negligible attack of the metal. This is possible because the inhibitor is effective at these temperatures. In addition to the beneficial washing action, the resulting natural circulation promotes distribution and provides a sufficiency of acid at the desirable locations at all times. Furthermore, the boiling operation sends solutions into certain regions at the top of the boiler which otherwise could not be reached except by recirculation with an elaborate system of internal baffling.

By contrast, inhibited hydrochloric acid can be used only at temperatures below 150-165 F. Above this temperature, the effectiveness of the inhibitor decreases with progressively more severe attack of the boiler metal. With hydrochloric acid, the acid cleaning process must therefore consist either of soaking or recirculation with external heating.

External heating by steam jets or heat exchangers increases the complexity and the cost of the cleaning operation, while attempts to utilize the sensible heat of the furnace and boiler without recirculation would introduce hazards of imperfect mixing, acid excess or deficiency, corrosion due to hot spots and the possibility of inadequate cleaning.

Other advantages cited by the authors were the greater stability of phosphoric acid which eliminated the corrosive and noxious fume problems of hydrochloric acid, and the rust resistant surface left by the use of phosphoric acid.

Even at room temperature, hydrochloric acid vapors leave the solution and as the temperature is increased to that encountered in boiler cleaning, the rate of decomposition becomes appreciable, the authors said. Since the inhibitor remains in the solution, its benefits do not extend to the vapor; thus the metal surfaces of drum, safety valves, boiler and superheater tubes above the level of the cleaning solution are exposed to corrosive uninhibited hydrochloric acid.

Effects of HCl Vapors

While the valves may be protected by their removal and superheaters by filling with condensate or isolation, there are always some regions that are beyond protection. During the cleaning operation with hydrochloric acid, invariably, HCl vapors pervade the plant atmosphere. These fumes are not only corrosive to power plant equipment, meters and exposed metal work, but also are toxic to plant personnel. In warm weather, ventilation may not be a serious problem, but in subfreezing temperatures as during the authors' first acid cleaning experience, the adverse effects of the fumes were noticed throughout the plant.

Phosphoric acid, by contrast, is extremely stable even at temperatures well above the boiling point of the solution used and, therefore, presents no corrosive or noxious fume problem.

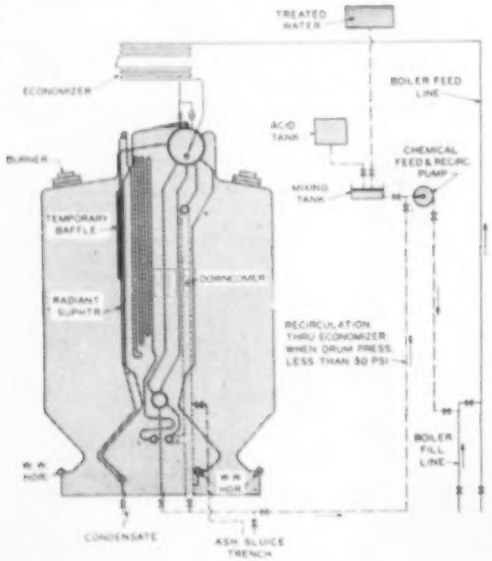
Hydrochloric acid, said Mr. Purcell and Mr. Whirl, possesses no passivating or film-forming properties and hence a most undesirable characteristic of its use is after-rusting of metal surfaces.

The freshly cleaned metal surfaces react rapidly with the atmosphere to form rust, especially in a moist condition. Even in the laboratory, a metal specimen which is rinsed rapidly with distilled water following acid cleaning, then dipped in alcohol and dried, will subsequently rust.

It was found that a 5 per cent inhibited phosphoric acid solution boiling at atmospheric pressure gave good deposit removal, negligible attack of metal and a surface resistant to rusting.

Above results and conclusions are based on both laboratory studies by the authors and on their successful application of the method to the cleaning of a new boiler.*

The paper gives detailed comments on the laboratory methods employed, as well as on the details of the boiler cleaning, presenting



Schematic diagram showing special drain and recirculation piping for cleaning by the phosphoric acid process described in text, of new boiler No. 3 at Frank R. Phillips Power Station

* It was the early work of Call, reported to the Chemistry Subcommittee of the Prime Movers Committee, Edison Electric Institute, together with the general passivating characteristics of phosphoric acid and the experience of the German Navy with cold 35 per cent phosphoric acid that prompted the authors' study of its use for cleaning purposes.

Much of the work by Call and the authors has also been essentially confirmed by Cardwell, as reported in the paper Prevention of Black Iron Oxide Deposits Following Chemical Cleaning by F. H. Cardwell, presented before the 12th Midwest Power Conference (to be published complete in the conference Proceedings).

Finally, note the comments on Question No. 462, Wants Instructions for Boiling Out a Boiler, *Power Engineering*, June 1950, page 92. These comments apply more to the usual medium and low-pressure boilers, rather than to the very high-pressure units discussed in the present paper.

Table I. Comparison of hydrochloric and phosphoric acids as boiler cleaning solutions

Hydrochloric Acid	vs.	Phosphoric Acid
Strong acid		Weak acid
HCl, a gas dissolved in water		H_3PO_4, a solid dissolved in water
Unstable, gives off corrosive HCl vapor which attacks metal above solution		Stable
Inhibitor not effective above 150-165F		Inhibitor effective at 212 to 220 F
Excessive attack of metal when used above 150-165F		Negligible attack of metal when used at 212 to 220 F
Process limited to "soaking" or mechanical recirculation		Can be boiled; permits direct firing, utilizing natural circulation
Promotes after-rusting		Prevents after-rusting
Corrosive acid fumes pervade plant atmosphere, requires ventilation		Non-fuming

Table III. Attack of metal by phosphoric acid pickle solution. Results of laboratory tests run for 6 hr at atmospheric boiling

Concentration H_3PO_4 wt %	Concentration Inhibitor* wt %	1x1x¼ in. Specimen Wt. Loss %	Remarks
1	0.00	0.96	Ppt. formed in 1 hr, acidity restored to original hourly
2	0.00	6.94	Ppt. formed in 2 hr, acidity restored to original every 2 hours
2	0.10	0.20	No ppt.
2	0.25	0.02	No ppt.
5	0.00	13.70	Ppt. formed in 3 hr, acidity restored to original
5	0.10	0.01	No ppt.
5	0.25	0.01 (Gain)	No ppt.

* Inhibitor in laboratory tests and field trial was NEP No. 22, a proprietary product of the Wm. M. Parkin Co., Pittsburgh, Pa.

fully the reasons for the various steps in the cleaning and for the use of the various chemicals.

In brief, the method of cleaning the boiler was as follows.

How a New Boiler Unit Was Cleaned

The unit to be cleaned was the No. 3 boiler unit at the Frank R. Phillips Power Station. This is a Foster-Wheeler twin-furnace-type steam generator, equipped with water-cooled furnace walls, radiant and convection superheaters, economizer, and air preheaters. The boiler is fired by pulverized fuel using two Hardinge ball-type pulverizers and 12 vertical intervane type burners.

The boiler is rated at a normal steaming capacity of 600,000 lb per hr. It is designed for a maximum output of 700,000 lb per hr and a maximum working pressure of 1,100 psi. Normal operating steam pressure and temperature is 900 psi and 900 F at the convection superheater outlet.

Total saturated heating surface in the boiler unit is 23,286 sq ft, of which 10,996 sq ft is boiler heating surface and 12,290 sq ft is in the water-cooled furnace walls. The other heating surfaces are: Radiant superheater—2,160 sq ft; convection superheater—15,600 sq ft; economizer—13,800 sq ft; and Ljungstrom air preheater—161,000 sq ft. The total effective furnace volume is 35,000 cu ft. The water required to fill No. 3 boiler to the normal operating level, which is 6 in. below the center-line of the drum, is 158,000 lb.

Since it was anticipated that this boiler would be acid-cleaned at some time, sufficient drains were provided to completely empty the boiler from normal level in less than one hour. After the acid boil-out during which both the economizer and the steam space of the drum were filled, it required just over 60 min to drain the boiler.

Steps in Chemical Cleaning Procedure

The chemical cleaning procedure consisted of the following steps:

A. Alkaline boil-out at an average pressure of 244 psi for a 24-hr period, using trisodium phosphate and sodium sulfite.

B. Acid boil-out at atmospheric pressure for an 8-hr period using inhibited phosphoric acid.

C. Alkalizing and surface conditioning boil-outs at an average pressure of 246 psi for a 12-hr period, using tetrapotassium pyrophosphate, potassium hydroxide and potassium sulfite.

The chemicals used and their cost appear in Table II.

Water used for the boil-out operation was "treated water" and condensate. The treated water is Ohio River water clarified by coagulation with ferrous sulfate and caustic soda in sludge blanket-type equipment, followed by filtration through anthrafilt.

The schematic diagram shows the special drain and re-circulation piping for the cleaning operation.

Preparation and Changes to Boiler and Piping

a. Sheet metal baffles were installed over the radiant superheater tubes to protect them from direct radiation of the oil fires during the acid boil-out when steam was vented directly from the drum to the atmosphere.

b. All safety valves were removed. The flanges on three superheater safety valve connections and one drum safety valve connection were blanked. A temporary safety valve set at 275 lb was installed on one of the drum safety valve flanges and a 3-in. vent from the remaining safety valve flange was connected through a 250-lb gate valve to the roof.

c. All blowdown valves were connected to a temporary 2-in tie line, one branch of which was connected to the suction side of the circulation pump and the other branch discharged to the ash sluice trench. This arrangement permitted circulation of the alkaline cleaning solution through the economizer when boiler pressure was below 50 psi and continuous circulation of acid solutions during this phase of the operation. The phosphoric acid solution was heated and circulated in the boiler by use of oil torches in the furnace. These are part of the regular equipment used in starting the boiler. The pump was necessary only for circulating the solution to the economizer. The mixing of the acid and feeding by gravity into the boiler proper could have been done just as easily by locating the tank at the economizer level.

d. During the acid boil-out only, to protect the superheater from acid

(Continued on page 108)

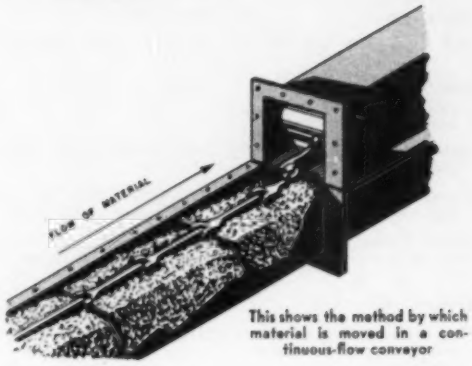
Table II. Quantity and cost of chemicals used for chemically cleaning new boiler

Chemical	Formula	Pounds Used	Cost Dollars	Phase of Cleaning in Which Used
Tri Sodium Phosphate	$Na_3PO_4 \cdot 12H_2O$	500	22.50	Strong Alkaline Boil-Out
Sodium Sulphite	Na_2SO_3	20	.75	Strong Alkaline Boil-Out
Phosphoric Acid	75%, H_3PO_4	14,850	1,262.25	Acid Boil-Out
NEP No. 22 Inhibitor	—	400	132.00	Acid Boil-Out
Phosphoric Acid	75%, H_3PO_4	375	31.88	Acid Rinse
Tetrapotassium Pyrophosphate	$K_4P_2O_7$	23	3.91	Surface Conditioning
Potassium Hydroxide	KOH	86	43.00	Surface Conditioning
Potassium Sulfite	K_2SO_3	14	3.47	Surface Conditioning
Total Cost of Chemicals			$1,499.76	

The Continuous-Flow Conveyor

By **WILBUR G. HUDSON**
Consulting Engineer

Here are some little-known facts about a very versatile machine . . . For power plant work, the continuous-flow conveyor has both advantages and limitations . . . Sometimes a financial advantage, sometimes an operating advantage . . . How the continuous-flow conveyor works and how it can be applied to power plant problems . . . Not suitable for abrasive materials like ashes . . . How to figure capacity and power required for various continuous-flow conveyor arrangements . . . Precautions to take in layout and operation



This shows the method by which material is moved in a continuous-flow conveyor

THE CONTINUOUS-FLOW conveyor-elevator has certain characteristics which on occasion, give it either a competitive or operating advantage over other types of conveyors. Also it has limitations that require consideration when engineering a project.

Typical Installations

Figures 1 and 2 illustrate the competitive advantage in two steam-plant coal-handling installations. In the first, Fig. 1, the specifications stated that all concrete work would be provided by the purchaser. That opened the door to a low-level belt conveyor mounted on supports purchaser thus had to provide, and a tandem continuous-flow elevator, capacity 40 tph priced at $16,000, as against $27,000 for the routine competitive layout shown at the top of Fig. 1, for which a major item of cost is the steel sheathed conveyor bridge.

In Fig. 2, the loop-type machine with a tandem flight conveyor, capacity 75 tph, was quoted and accepted at $18,000 as against $24,000 for the gravity-discharge elevator-conveyor shown above. The long horizontal run of the latter machine, and the upper turn supports, run into considerable money.

Figure 3 shows an installation for handling wood chips at 10 tph for a roofing paper plant. Cars are unloaded at a siding 200-ft from the storage building. The chips pass through a vibrating screen, Fig. 4, to cull out blocks of wood and are conveyed (2) at ground level to a loop type elevator (3), which forms the storage pile. The movement from storage or direct from (2) is as indicated. Here there is the advantage of the enclosed duct, the essentially self-supporting inclined run of (3) and the self-loading-to-capacity feature of (3), eliminating gates along the run beneath the storage pile.

Advantage of Self-Loading Feature

The self-loading feature without risk of overloading, thus eliminating a feeder, is interesting. Assume a horizontal conveyor with a succession of feed openings to the upper (loading) run, beneath a pile of free-flowing granular or pulverized material. The flow through the first opening fills the duct to capacity and, so long as it continues, blocks off flow from succeeding openings. If the first opening flow should be momentarily suspended — as from arching—the next opening will automatically start feeding, but will be blocked off when the first resumes feeding. The material passes down to the lower or carrying run just ahead of the foot end. If it is desired to mix materials flowing from two openings, the cross-section of the feed-run of the duct may be suitably modified.

Precautions in Layout and Operation

Again, certain precautions are necessary. Figure 5 shows a gravity feed to a crusher and feeder geared to 80 tph with a bar grid ahead of

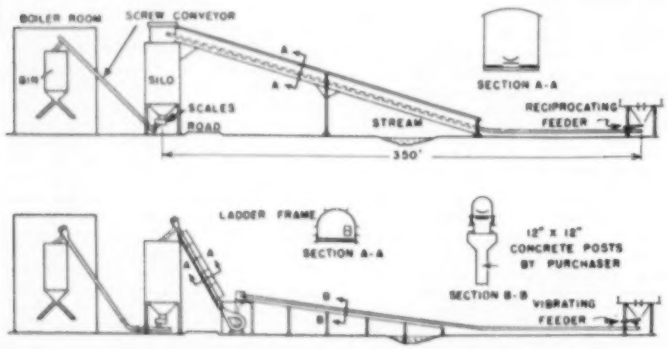


Fig. 1. Competitive layouts for a boiler-house coal-handling installation. Layout at top using conventional belt conveyor cost $27,000. Layout at bottom, using flatter, shorter belt conveyor plus continuous-flow elevator in tandem, cost $16,000 and was selected

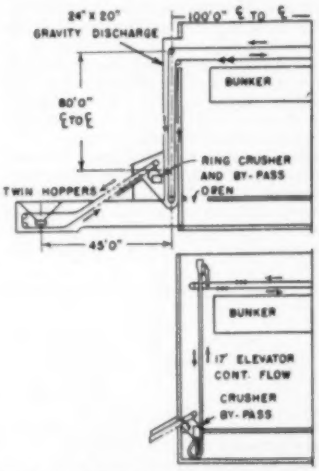


Fig. 2. Two layouts for a boiler house. Upper layout cost $24,000. Lower layout cost $18,000 and was selected

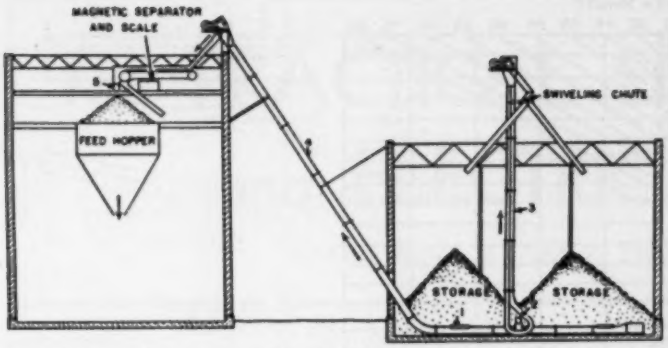


Fig. 3. Continuous-flow conveyor worked out well here for handling wood chips. Conveyor (2) extends from screen shown in Fig. 4. Elevator (3) and chutes form storage piles. Elevator (4) feeds from piles or direct from (2). Conveyor (5) distributes to service storage

Fig. 4. This vibrating screen feeds chips to 200-ft continuous-flow conveyor (2) running along ground to elevator (3) in Fig. 3

the feeder to by-pass undersize. The layout is unworkable. If, say, 20 tph of undersize passes through the grid to the loading run of the duct, there remains insufficient duct space to receive the crusher output. The material will back up and stall that unit. However, if the grid is located between the feeder-end and the crusher, with a **common flow** to the duct, there will be no complication.

A routine method of feeding coal to a line of stoker hoppers is a horizontal screw conveyor with discharge above each hopper. One bothersome operational detail is that surplus coal spills out on the floor at the far end, requiring more work and equipment to recover it. With a continuous-flow conveyor, the coal is carried out in the upper run, passes down to the return run at the far end, feeds out, and any surplus is chuted back to the elevator.

There are conditions where a horizontal or rectangular path run-around conveyor is called for. A flight conveyor has trouble here. As the flights round the terminal sprocket, the loaded compartments between adjacent radial flights open; and, as the flights resume parallelism, material is squeezed and something must let go. A continuous-flow conveyor with skeleton flights, as shown in Fig. 6, does not have this objection, for the material freely adjusts itself as the adjacent sections change.

This feature works in nicely when a horizontal run-around is located beneath a bunker to feed a succession of stokers or pulverizers; or, at times to handle material from different sections of a bunker to any boiler.

A final good feature of this conveyor is that material which must not be exposed to contamination or to exposure, such as face powder, tooth powder, sugar, grains, drugs, and the like, is completely protected because of the dust-proof duct.

Cautions

Since the element is drawn through a rigid duct, it is clear that trouble may develop with a material containing unbreakable lumps large enough to jam between duct walls and the impellors — gravel, for example. Again, since the material is in sliding contact with the duct walls, the machine is not advisable for such abrasives as ashes or sand, nor for corrosive materials that will eat through the steel plate.

Material that is fragile will be broken up more or less; however, the machine does have the advantageous feature that discharge may be through spaced openings along an up run, as in Fig. 7, showing an installation for storage of briquettes. In this case provision was made for drawing out stored briquettes with minimum breakage by guiding the outflow always from the top of the pile.

Capacity Chart

There are several types of continuous-flow conveyors available, but the chart, Fig. 8, will give approximate handling capacities of all, for various duct cross-sections and speeds. They are essentially slow-speed machines, usually specified for 50 fpm or slower. Speeds faster than 75 fpm are undesirable.

Power Formula

The power requirement may be approximated by the formulas given in Fig. 9. Power is a function of the path and the friction coefficient of the material handled. The power for a horizontal conveyor with a single active run does not differ much from that for the correspond-

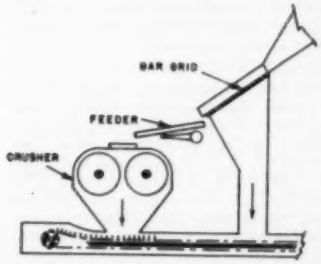


Fig. 5. This is NOT GOOD. By-pass grid ahead of feeder will deliver fines to continuous-flow conveyor which will back up and stall crusher, or, at least, reduce its capacity. Put grid between feeder and crusher, with common flow to conveyor duct

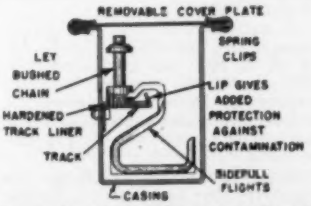


Fig. 6. Special construction for horizontal run-around path. Chain carried clear of load. Skeleton flights carried clear of duct

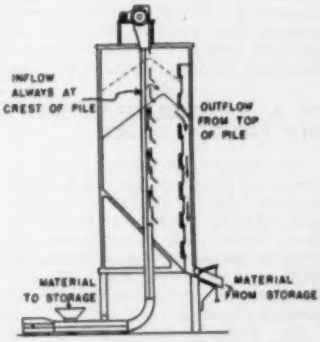


Fig. 7. Vertical leg with successive discharges to reduce breakage with fragile materials such as briquettes

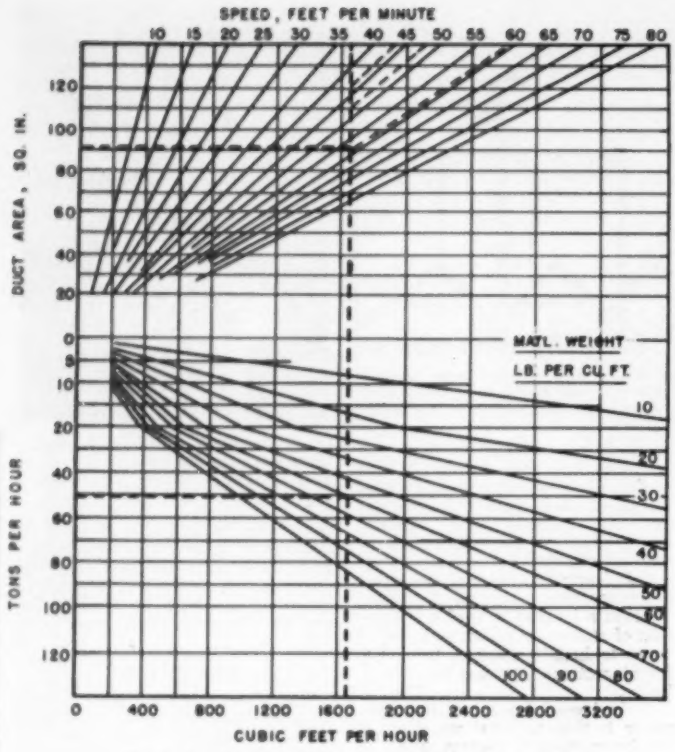


Fig. 8. Speed-capacity chart for continuous-flow conveyors

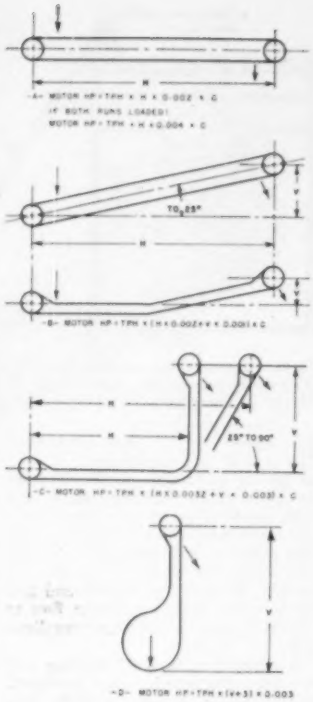


Fig. 9. Power formulas for various continuous-flow conveyor paths. Values of C in table

Table giving Values of C for Fig. 9 formulas, for various materials

	C = 1			C = 1.5	
Bran	Graphite flake	Soybeans	Talc	Salt, pulv.—1.5 to 2	Salt, rock
Coffee, ground	Nut kernels	Coconut, shredded	Starch, pulv.		Wood chips, wet
Cocoa beans	Soap flakes	Copra, ground			
Flaxseed				C = 2	
	C = 1.2		Clay—2 to 2.5	Starch, granu.	Soda ash, light
Beans	Charcoal	Soybean meal—1.2 to 1.5	Fly ash	Sugar, granu.	Sugar, pulv.—2 to 2.5
Coal ¼x0	Copra cake	Wheat	Lime, pebble		Zinc oxide
¾ slack	Flour—1.2 to 1.5	Wood chips, dry		C = 2.2 to 2.5	
Coffee beans	Sawdust do.		Alum	Lime (packs)	Tobacco scraps
			Borax	Soda ash, heavy	Limestone, pulv.
			Cork, ground		

ing flight conveyor, which it then resembles. The power for a continuous-flow elevator is about 50 per cent greater than for the corresponding bucket elevator. It costs substantially less than a bucket elevator with feeder and requires far less installation space. Bucket elevators require an automatic brake or back-stop to prevent reversal should the current fail. The continuous-flow elevator does not need a back-stop, because the loaded element will reverse only a foot or so if released.

DR. A. A. POTTER, OF PURDUE, NEW PRESIDENT OF BCR

The board of Directors of Bituminous Coal Research, Inc., the national research agency of the bituminous coal industry, on June 6 elected Dr. A. A. Potter, dean of engineering of Purdue University, as president of BCR on a part-time basis. He will continue to serve Purdue in his present capacity.

Dr. Potter's entire professional career has been spent in research and education in the fields of fuel and power generation. He has been honored repeatedly for professional achievement. He is a past president of the ASME.

A native of Europe, Dr. Potter came to the United States at the age of 15, in 1903 was graduated from MIT, has been awarded honorary degrees of Doctor of Engineering, Doctor of Science, and Doctor of Letters by several colleges and universities.

From 1903 to 1905, Dr. Potter was employed by the General Electric Co. at Schenectady, and in 1905 joined the staff of Kansas State College as assistant professor of mechanical engineering. In 1913, he became dean of engineering and director of the Engineering Experiment Station at Kansas State, but resigned in 1920 to accept the position of dean of engineering schools at Purdue. Since that time he has served as dean and director of the Engineering Experiment Station and the Engineering Extension Service and served as acting president from July 1, 1945 to January 1, 1946.

For more than 30 years, Dr. Potter has served also as a consulting power engineer, and is the author of books on power engineering.

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

HOT STUFF

Power engineers accustomed to the use of high temperatures in boiler furnaces realize, of course, that the temperatures attained even in the highest rating boilers fall far short of temperatures which are attained in certain industrial and chemical processes. The oxy-acetylene torch, for example, produces temperatures of around 6000 F and the crater of the carbon arc runs as high as 6600 F. Tungsten melts at around 6100 degrees.

There is still another method, however, which gives an even higher temperature and curiously enough it is a relatively simple one—one that many of us tried out when we were young. It is simply the ***burning glass***. It is by means of the same principle—concentrating the rays of the sun—that man obtains the highest temperatures he has ever produced on earth, short of the atomic bomb itself.

As told in the current issue of Popular Science, at the Observatory of Meudon in a little French suburb, there is a solar furnace which may well be the hottest place on earth. For this furnace, which looks like a searchlight, yields an estimated temperature of about 9000 degrees F. This approaches the temperature of the surface of the sun which is estimated to be about 10,700 F. This furnace melts or turns into vapor anything you can name.

Actually the furnace consists of a 72-in. parabolic mirror which collects the sun's rays and reflects them on to an 18-in auxiliary water-cooled plain mirror. This plane mirror, intercepts the converging rays and turns them downward upon material in an upright crucible. The superhot source of the furnace heat is a 5/16 in. diameter image of the sun formed at the focus. Theoretically, this image of the sun might match the 10,700 deg surface temperature but the atmosphere and the mirrors absorb some of the energy so the actual temperature in the furnace is somewhat lower. When placed in the crucible, a one-ounce chunk of iron melts in ten seconds and partly vaporizes.

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How Consolidated Edison of N. Y. Maintains Its Storage Batteries

By K. A. VAUGHAN
Manager, Field Engineering, Gould Storage Battery Corporation

THE CONSOLIDATED Edison Co. of New York Inc. serves what is undoubtedly the largest concentrated market for electricity in the world. To service properly this market, it has the obligation of supplying electric power to its consumers at all times, regardless of extenuating circumstances. To do this, a vast network of generating equipment has been developed, along with an even more vast network of controls, safety devices, and indicators. These controls, safety devices, and indicators make up the nerves which carry to central control boards messages as to the operating conditions of generating equipment. Therefore, it is essential that they function at all times.

Most controls operate on direct current. Control circuits have their own source of supply, generally motor-generator sets. Since controls must operate at all times, and since there is always the possibility of motor-generator failure, it is imperative that standby power be available in the case of such an emergency.

It is to supply this emergency control-power, plus emergency power for such miscellaneous jobs as field excitation and house service, that Consolidated Edison has over 275 storage batteries, comprising thousands of cells, distributed throughout its system. These batteries are designed to take specific loads in case of power failure until auxiliary equipment has been installed or until repairs have been made.

Just as it is important that the batteries be present, it is also important that they be properly installed and maintained. A given battery may be called upon but once in several years, but it must be capable of delivering full capacity when it is called upon.

Fig. 1. Recording voltmeters across the batteries indicate whether or not the battery has been at the correct voltage over the past period battery

Fig. 2. When the storage is installed in a room with other equipment it is housed in a cabinet as shown in this photograph

All of Consolidated Edison's stationary batteries are installed on racks. These racks are either of wood or metal. Metal racks are insulated from the floor, are level, and set firmly. All cells are easily accessible for maintenance purposes.

Rooms in which batteries are installed are well ventilated (to carry off gases); away from high-temperature areas (to prevent excessive self discharge); and away from dusty locations (to prevent batteries from becoming dirty and the possible development of shorts or grounds). When the installation is in a room with other equipment, it is housed in a cabinet as in Fig. 2. This prevents the accidental laying of tools on top of batteries, accidental knocking over, and excessive dust or dirt from accumulating.

Consolidated Edison has developed a maintenance schedule designed to keep all batteries in good operating condition at all times and to assure maximum battery life. The Battery Division comprises 17 men and it is their duty to maintain properly the battery system. Their work comprises:

(1) Keeping the batteries clean,
(2) Adding water when required,
(3) Seeing to it that the batteries are charged correctly,
(4) Keeping battery records,
(5) Providing for the repair or replacement of batteries which are not giving satisfactory service, and

(6) Making battery discharge tests.

To accomplish these tasks, all stationary batteries receive a monthly inspection and equalizing charge, and all batteries in unattended stations receive an additional inspection every two weeks. If attention is required between the monthly checks, personnel at attended stations notifies the Battery Division. As noted, the Division itself inspects the unattended stations mid-way between monthly check-ups to see that the batteries are functioning properly.

In scheduling maintenance operations, assignment sheets are drawn up for each day's work. A sample sheet might be as follows:

BATTERY DIVISION — 8 A.M. - 4 P.M.

EMPLOYEE	STATION	DUTY
A	Hell Gate	Charge truck batteries
B	Hell Gate	Check keepalite batteries Water No. 1-2-3 excitation batteries
C	W. 45th St.	Charge control batteries
D	W. 97th St.	Charge control batteries
D	Waterside No. 2	Charge truck batteries
F	Waterside No. 2	Check control and keepalite batteries
G	E. 39th St.	Painting numbers on No. 1 control battery rack
H	E. 39th St.	Painting numbers on No. 1 control battery rack
I	E. 6th St.	Remove, clean, and install intercell connectors of No. 1 control battery
J	E. 6th St.	
K	Jamaica	Charge control batteries
L	Hudson Ave.	Charge truck batteries
M	Hudson Ave.	Check keepalite batteries
N	15th St.	Office
O		Vacation
P		Vacation
Q		Foreman

The most important phase of the monthly checkup is the equalizing charge. The equalizing charge comprises charging the battery at the "finishing rate[1]" to be sure all cells are brought up to full charge. The battery is given an equalizing charge at the finishing rate and readings of voltage specific gravity and temperature are taken after four successive equal readings are obtained. At this time, all cells should be fully charged.

Just before the termination of the equalizing charge, the voltage of each cell is read and recorded. Approximately 10 minutes after charge is terminated specific readings of each cell and temperature readings of every tenth cell are taken and recorded. If any cell is not up to full charge, steps are taken to replace or repair it. This generally involves calling in the battery manufacturer's representative for recommendations.

At the time the equalizing charge is applied, each cell is wiped clean with a cloth and electrolyte levels are checked. When water is required, it is added.

The bi-monthly checks of unattended stations include a visual check of the installation and pilot cell readings. The Consolidated Edison Co. has installed recording voltmeters across the battery at some unattended stations, and at some attended stations, which indicate whether or not the battery has been at the correct voltage over the past period. Such an indicator, as well as a copper oxide charger, is shown in Fig. 1. The charger maintains the Gould battery shown in Fig. 2, in a fully charged condition. This 60 cell, 4.95 ampere-hour battery (at the 1-hour rate of discharge) operates a relay which starts up and shuts down rotary converters located within the unattended substation, but controlled from another station some 5 blocks distance.

In addition to the scheduled monthly and bi-monthly checks, once each year each battery receives a discharge test to determine whether it can deliver rated capacity when called upon to do so. This test is also given all new batteries within one year of the purchase date in order to catch any defects before expiration of the guarantee period.

When applying this test, the battery is first given an equalizing charge to make certain it is fully charged. Then the battery is discharged to a final voltage of 1.75 v per cell. The time it takes to discharge this voltage and the amperes delivered during this period are recorded and the ampere-hours calculated by multiplying the two. If a battery is rated at 60 ampere-hours when discharged at the 1-hour rate, it should, of course, deliver 60 amp for one hour at 77 F. If it reaches final voltage while delivering 60 amp in say 50 min, the battery is delivering but 5/6, or 83.3 per cent, of rated capacity at 77 F. This test, taken in consideration with the age of the battery, will determine whether a new battery is required. For example, 83.3 per cent would be satisfactory for a new battery since new batteries normally deliver about 85 per cent of rated capacity. It costs extra if a battery is to give rated

[1] When batteries are fully discharged, they are charged at a high starting rate, and when about 80 per cent charged, the charge is continued at a low finish rate. Recommended finish rates for given batteries are supplied by battery manufacturers.

Fig. 3. Battery which supplies shunt field current to a 30,000 kw generator in event of failure to normal supply

Fig. 4. Typical battery installation. Notice the cleanliness and openness of the installation as well as the fact that racks are insulated from floor

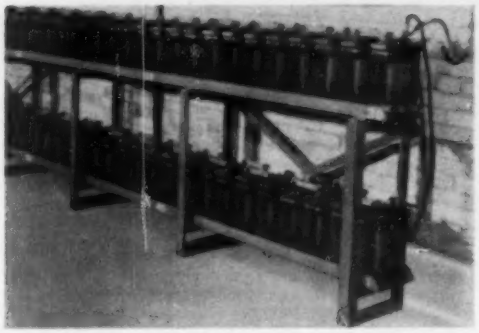


Fig. 5. This 60 cell, 20 amp hr battery supplies emergency power for indicating lights and alarms

capacity upon delivery since the battery manufacturer must successively charge and discharge (or "break-in") the battery until brought up to rated capacity. If 83.3 per cent were recorded for a battery which has been in service for some years, depending upon the type of battery and the service demands, it would be an indication that the battery is beginning to wear out and that a new one should be considered.

A master-record is kept on each battery. This form provides spaces for the battery location, type of service, battery manufacturer, type of battery, number of cells, ampere-hour rating, date installed, estimated life, and date retired. In addition, space is provided in which to record the results of discharge tests for a period of 16 years. Space is also provided in which to record remarks as to general satisfaction with the battery.

When a battery is to be replaced, the Engineering Department, which has a duplicate master-record, is notified and given Discharge Test data along with a recommendation for a new battery. Bids are sent out by the Purchasing Department to the various manufacturers and a replacement bought. Service given by the previous battery is one of the factors considered when buying a replacement.

Records are also kept of each monthly inspection. This form includes spaces for the battery location, date, number of cells, number of plates per cell, time put on charge, time taken off charge, charge rate, generator voltage, remarks, and the inspector's signature. A table for the pilot cell readings taken during the equalizing charge includes columns for recording cell number, time of taking pilot cell readings, specific gravity, voltage, temperature and electrolyte level. A table for recording information on each individual cell during and after the equalizing charge includes columns for readings of specific gravity, and voltage. Temperature is recorded for about every tenth cell.

These records provide a written case history of the battery and draw supervisory attention to any deficiencies. Thus, stationary batteries are kept in excellent operating condition at all times and are capable of delivering their rated capacities during their full life of from 8 to 12 years, depending upon the type of battery.

Although most batteries are seldom called into play, it is, nevertheless, imperative that they be properly maintained for that day when they will be required.

For example, if the field current of, say, a 30,000 kw generator were to fail, the output of the generator would cease. To supply current to the shunt field of the main exciter in the event of failure of the normal supply, the Gould battery in Fig. 3 is maintained. This is a 120 cell 48 ampere-hour battery (at the 1-hour rate of discharge). Cells are grouped in hard rubber containers, 4 cells per container. It can supply current to the exciter: (1) while the normal source is being restored, (2) an auxiliary source is connected, or (3) another generator is put in service and this one taken out. Thus, it will prevent disruption of service.

Figure 4 and 5 show typical battery installations. Notice the cleanliness and openness of the installations as well as the fact that cells are numbered and that racks are insulated from the floor. The 60 cell, 20 ampere-hour battery (at the 1-hour rate of discharge) in Fig. 5 supplies emergency power for indicating lights and alarm signals which tell the system operator (i.e., central control of the entire network) whether specific outlying units of equipment are in use or not.

Batteries such as the Gould battery in Fig. 4 supply stand-by power for house service. This particular battery has 118 cells and 220 ampere-hours capacity at the 1-hour rate of discharge. Similar units service hundreds of circuit breakers, valves, motors, and indicating lights throughout the Consolidated Edison System. Should normal control power be interrupted, the batteries permit controls to be electrically operated until service is restored.

These are but a few of the Consolidated Edison's many battery installations, but they serve to point out the importance of properly maintaining the standby battery system.

Viscosity of Fuel Oils

In this fifth article on the characteristics of fuel oils, Mr. Schmidt discusses the meaning of viscosity, the methods of measuring it and its significance in evaluating the merits of fuel oils for combustion

By PAUL F. SCHMIDT
Allied Oil Company, Inc., Cleveland, Ohio

THE VISCOSITY of an oil is the measure of an oil's ability to be pumped or flowed, or its resistance to flow.

The instrument used to determine the viscosity is called the Saybolt Viscosimeter, of which there are two types, namely, Universal and Furol. The only difference between the two types, is the size of the opening at the bottom of the outlet tube, through which the oils flow to be measured.

The Universal instrument is used mainly for the lower viscosities, up to 1000 seconds, the Furol for the higher viscosities above that.

Method of Testing

The viscosity is determined by the length of time, in seconds, required for 60 cubic centimeters of oil, at a definite temperature, to flow through a standard orifice tube. This tube is surrounded by an oil bath, kept at the temperature of the test.

Temperatures of Test

The temperature at which the test is run varies with the type of instrument used, and the viscosity of the oil. The operating temperatures for the Universal are 70, 100, 130, and 210 deg F. For the Furol, the temperatures are 77, 100, 122, and 210 degrees. The 100 degree temperature with the Universal, and 122 degree temperature with the Furol, are the most frequently used temperatures, while the others may be used in special cases, or for a specific purpose. The higher temper-

atures are usually used when an oil is extremely viscous, otherwise the time required to run the test will become exceedingly long.

Explanation of Viscosity Readings

It is absolutely necessary when quoting a viscosity reading, that the type of instrument and temperature be included, otherwise the reading is useless. To illustrate, a viscosity may be shown as 500 SSU at 100, meaning 500 seconds Saybolt Universal at 100 degrees. To simplify further, this means that at 100 F, it took the oil sample, 500 seconds to run completely through the Saybolt Viscosimeter. A reading as 200 SSF at 122, means a viscosity of 200 seconds Saybolt Furol, at 122 degrees.

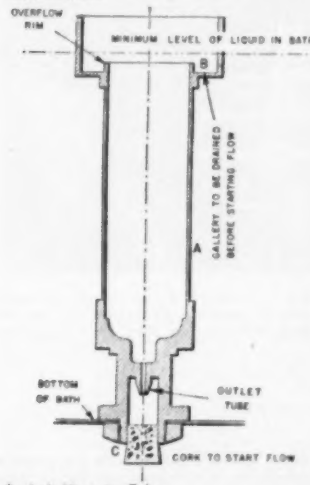
Conversion Ratios Between Universal and Furol

The outflow time between the Universal and Furol instruments at the *same* temperature, has a ratio of approximately 10 to 1, but as the usual tests are run at temperatures of 100 F and 122 F the ratio becomes wider. These ratio factors, as shown in the table, are frequently used with industrial oils of grade No. 5 and 6. Very often the specifications are listed in one way, but the other is desired, so these ratios will be helpful for converting.

Viscosity Change With Temperature

As an oil is heated, the viscosity decreases or thins out, and this physical property is used advantageously in various ways.

When an oil is viscous, it is impossible to obtain the proper atomization for the most efficient combustion. The viscosity of this oil must be reduced by increased heat in the storage tank, or in the preheaters. This increased heat will thin-out the oil, so as to make it easier to atomize, or to form a fine spray or mist, so necessary for complete combustion.



Saybolt Viscosity Tube
Inside dia of Universal Outlet Tube 0.1765 cm. Inside dia of Furol Outlet Tube 0.315

CONVERSION RATIOS BETWEEN UNIVERSAL AND FUROL

Viscosity at 100 F, SSU	Viscosity at 122 F, SSF	Ratio
300	21	14 to 1
400	26	15 to 1
500	30	16 to 1
600	34	17 to 1
700	38	18 to 1
800	40	20 to 1
900	45	20 to 1
1000	50	20 to 1
1200	60	20 to 1
1500	75	20 to 1
1800	90	20 to 1
2000	100	20 to 1
2200	111	20 to 1
2500	115	21 to 1
2800	125	22 to 1
3000	135	22 to 1
3200	140	23 to 1
3500	145	24 to 1
3800	150	25 to 1
4000	160	25 to 1
4200	165	25 to 1
4500	170	26 to 1
4800	180	26 to 1
5000	190	26 to 1
5200	196	26 to 1
5500	200	27 to 1
6000	220	27 to 1
6500	240	27 to 1
7000	260	27 to 1
7500	270	28 to 1
8000	285	28 to 1
8500	300	28 to 1
9000	320	28 to 1
9500	335	29 to 1
10000	342	29 to 1

Where there are enough heating facilities in the storage tank, and large preheaters, the viscosity does not need to be watched too closely. Where there are none, or little heating equipment available, the viscosity must be watched in cold weather. In this case, the viscosity of the oil should be ascertained for the lowest operating temperature that will be encountered, and a suitable viscosity oil for that temperature should be purchased. This saves a lot of trouble as fuel oils can become unpumpable in cold weather.

If the viscosity is too high, it may be necessary to reduce it by blending with a lighter oil. Some consumers use two different grades, a heavy one for warm weather, and a lower viscosity oil for the cooler weather.

From the illustrations shown, it will be seen how high and tremendous the viscosities become as the temperatures decrease, which should make it easily understandable how trouble occurs in cold weather. Also how easily this trouble can be eliminated by the addition of a little heat. To help with ease of reading, all viscosities shown are on the Universal instrument.

The viscosity of fuel oils particularly the residual oils at low temperatures will be depended primarily upon the pour point of the oil. Secondary factors governing the change in viscosities, are type of crude, type of refining, degree of blending and blending components.

Oils with the same viscosity at 100 F will not always have the same viscosities at different temperatures. As an example, one 500 viscosity oil will have at 60 F a viscosity of 2700 seconds, while another oil of 500 seconds at 100 F will have a reading of 3330 seconds at 60 F.

Viscosity and Gravity Relation

As you glance over the following figures, you will notice that some viscosities with high gravity, are higher than some viscosities with low gravity. This is against the theory held by some consumers, that is, a low gravity oil always means a high viscosity. This is not absolutely correct, and should be remembered.

API Gr	SSU, 100 F	API Gr	SSU, 100 F
10.4	1056	10.8	840
11.6	1047	13.0	3000
13.7	1000	22.0	900
18.2	1020	22.1	2065

Buying an oil by gravity alone, is not too good a policy. Oils may have the same gravity, and therefore approximately the same heat of combustion, but can have entirely different viscosities. This means that those oils with a light viscosity will go through some burners faster, causing greater fuel consumption. Blended oils will have varying gravities and viscosities, due to the blending components.

Viscosities of Various Grades

Viscosity ranges for the various grades, are listed as follows:

No. 2 oil 34 to 40 sec at 100 F Saybolt Universal

No. 4 oil Min. 45 sec at 100 F Saybolt Universal
Max. 125 sec at 100 F Saybolt Universal

No. 5 oil Min. 150 sec at 100 F Saybolt Universal
Max. 800 sec at 100 F Saybolt Universal

No. 6 oil Min. 45 sec at 122 F Saybolt Furol
Max. 300 sec at 100 F Saybolt Furol

According to the viscosity range of a No. 5 oil, as shown, the viscosity can be from 150 sec to 800, and still be called a No. 5 oil. This range, as you will realize, is extremely broad, and should be re-

40 F	50 F	80 F	100 F	130 F	150 F	170 F	200 F
100,000	50,000	8,000	3,000	950	500	300	150 S.S.U.
50,000	25,000	5,000	2,000	600	390	230	125
20,000	10,000	2,200	1,000	390	230	150	90
12,000	7,000	1,600	750	300	180	120	78
6,000	3,800	1,000	500	220	140	100	66

membered when discussing this grade of oil. You may be able to burn and handle a No. 5 oil of 150 sec, but would have trouble with a No. 5 oil of 800 sec. Some oil companies quote their oil as No. 5-300, meaning, a No. 5 oil having a viscosity of 300 seconds at 100 FSU. With this type of wording, it shows not only the grade, but the viscosity as well, which is quite helpful when purchasing and using. These viscosity variations hold true with No. 6 oil as well. The No. 2 and 4 oils do not have this great spread so they are quoted only by their grade number.

If it is necessary to pick out one specification with the greatest imporance to an oil, viscosity must be chosen. This is especially true with No. 5 and 6 oils.

For maximum efficiency, the operating engineer should know the viscosity of the oil he is burning, and should make the necessary adjustments in operating procedure as the viscosity varies. This is particularly true regarding pumping temperatures, atomizing temperatures, and oil pump pressures to his burners.

Trying to burn a high viscosity oil, where a low one is required, only invites trouble and should be avoided. This is sometimes attempted due to the lower price of the heavier oil.

If a too low viscosity oil is used, where a heavier one could be utilized, the consumer will have a loss of heat, as most low viscosity oils are blended. These oils will therefore have a high gravity, with a resulting decrease in Btu value.

New Banding Process Makes Better Motors

Use of stainless steel bands, applied by special fixtures, and welded in place by Eutectic welding strengthens electric motor rotors

By **RENE D. WASSERMAN**
President, Eutectic Welding Alloys Corp.

IN BUILDING and repairing electric motors, the industry has made very few changes in armature design in many years. Now, however, a brand new idea appears destined to make sweeping changes in the accepted methods. Always quick to recognize and accept new improvements that will cut their maintenance and operational expenses, many of the largest steel mills and railroads in the nation are already doing the bulk of their electric motor rebuilding with this new technique. Several of the best known names in the electric motor manufacturing field are also currently completing negotiations for licenses that will permit them to incorporate these changes in their own production.

Standard methods have long utilized copper wire wound under tension to form copper bands in several places across the face of the armature. Soft solders were usually used to bond these wires together. The main weakness of this method became apparent in operation. The faster the armature turns, the greater the stress that is applied to the bands through centrifugal force. Clearances between moving and fixed parts are very slight, and broken or even loosened strands frequently cause the band to fail in its purpose and permit serious damage to the motor.

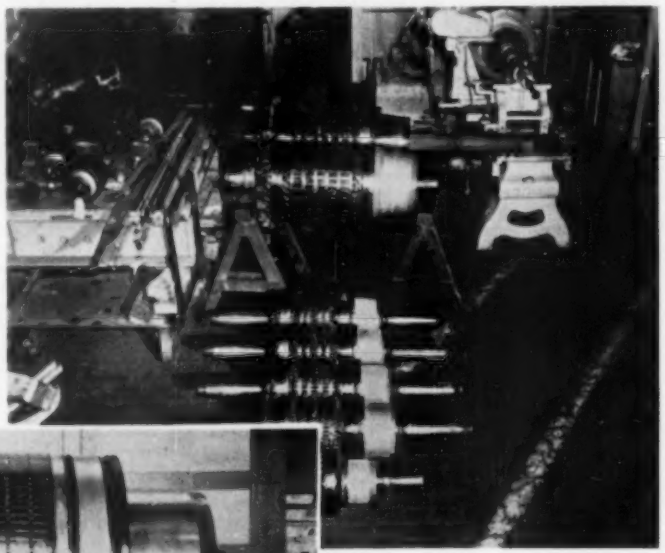


Fig. 1. (Above) An assortment of several sizes of armatures which have all been rebuilt with stainless steel banding process

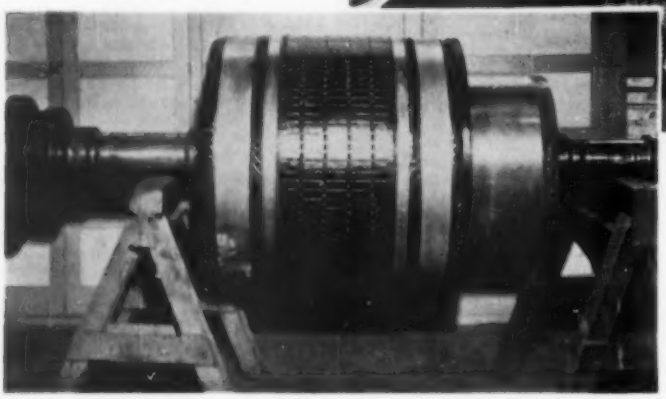


Fig. 2. (Left) A 500-hp, 600-v d-c armature rebuilt with solid stainless steel bands. These bands, it is claimed, will last for the full life of the motor without repair or replacement

Stronger metals or better banding methods hadn't worked out because of the difficulty of bonding band ends without damaging the thin layer of insulation underneath. Now, a successful new process is using stainless steel bands to supplant the copper banding completely. Special fixtures apply carefully predetermined tension for each band size as the hi-tensile stainless strip is fitted in place. Both ends of the strip are precisely beveled so that the joint when finished is no thicker than the strip itself even through the joint may be several inches long.

Stainless band ends are carefully cleaned and then coated with Eutector Flux 1800. A piece of 0.003 in. thick EutecRod 1800 foil is carefully placed between the beleved sections. Either torch or induction heating is used to bring the joint up to a heat where the alloy is fluid, and a light pressure is applied to the upper side of the joint. This forces the excess metal out, and the pressure is maintained until the EutecRod 1800 joint has solidified.

When the fixture is removed, the stainless steel is tightly and permanently joined—so well joined that it is often difficult to find the weld. For all practical purposes, it might just as well be one piece of metal because the EutecRod 1800 joints give the band the strength of continuous metal. There is no weak link to be a source of possible band failure, yet the stainless steel strip can be quickly removed in an instant whenever necessary.

During the four years of development work that went into this method, the joining of the band ends offered the most serious problem that had to be overcome. Ordinary welding heats destroyed the insulation beneath the weld. Virtually every commercial alloy that offered a possibility was tried and tested to find one that would meet all of the needs of the problem.

When experimentation was complete, EutecRod 1800 was found to be the only alloy that met all of the rigid specifications. Of paramount importance, EutecRod 1800 did a perfect job of joining the stainless strips at only 940 F, a heat at which bonding could be completed without damaging the insulation. Secondly, the joints have withstood pulls of up to 117,000 psi. This provides a strength factor over copper banding of 5 to 1, more than sufficient for all phases of motor operation without danger of failure.

Actual figures show that the cost of banding has been cut a full third, and it has been conclusively proved that the original banding will last for the full life of the motor. To date, more than 100,000 motors of all sizes up to 3000 hp have already been stainless steel banded with this new method and the total is growing rapidly.

The company which developed this method has standardized on EutecRod 1800 because they believe that it is essential if consistently high quality results are to be obtained. When licensing other firms, they are definitely recommending EutecRod 1800 as the alloy best suited for the assembly. Once again, modern welding technique has served to point the way to better products in industry.

The Drop-Count System of Water Analysis

By CLIFFORD C. HACH
Hach Chemical Company, Ames, Iowa

IN THE COMMERCIAL testing of water for its various components, such as hardness alkalinity, chlorides, sulfates, iron, carbonates, hydrogen sulfide and other substances, an absolute testing accuracy of 5 percent is generally sufficient. Many of the analytical procedures themselves give results which are no more accurate than this.

The Drop-Count principle of water testing has been used for years, though in the past this system has given undependable results. In order to provide testing equipment at a very low cost, yet accurate enough for nearly all practical purposes, the Drop-Count system has been greatly improved. Standard test procedures are employed, however instead of using a burette to titrate the water sample, an accurately standardized dropper is used. Droppers that deliver one tenth of a milliliter per drop, with an accuracy of five percent are used to dispense the titrating solutions.

Fig. 1. The Water Hardness Tester

Directions: Fill the small test tube full of the water to be tested and pour it into the mixing bottle.
2. Add one full measure of powder from bottle two.
3. Add solution 3 dropwise while the drops are counted, until the color of the solution changes from red to blue. The hardness of the water in grains per gallon is equal to the number of drops used.

Fig. 2. The Drop-Count Hardness and Iron Combination Tester

A thorough study has been made on the design and operation of dropper tips, and a design has been produced that meets the following specifications:

(1) The droppers consistently deliver 0.100 ml. (plus or minus 0.005 ml.)

(2) The droppers will give the correct size of drops immediately upon being put into service—no preliminary cleaning and conditioning (wetting) treatment is necessary.

(3) The angle at which the dropper is held has a negligible effect upon the amount delivered.

(4) The drop size is substantially constant regardless of the rate that the drops are dispensed.

(5) The dropper tubes can be mass produced.

Ordinary droppers vary widely in physical dimensions as well as in performance. The most common type dropper is made with a drawn-out tip. The drop-size obtained from this type of dropper is affected greatly by the angle at which the dropper is held. Also the tips are not uniform in size. Another common commercial type has a blunt round tip, and the greatest trouble

with this type of reproducibility.

At the present time there are drop-count water hardness testers on the market which employ ordinary commercial dropper tubes. One of these testers was recently tried out and it gave values 30 per-cent low when the dropper was held in a vertical position and 50 per-cent low when the dropper tube was inclined to 45 degrees. Such inaccurate testers have given a bad name to the drop-count system.

Drop-Count water hardness tester using the standard 1/10 ml. droppers are being successfully used by salesmen of domestic water softening equipment, as well as in smaller municipal water treatment plants. Small testers are being used successfully by plumbers and householders in connection with the maintenance of domestic water softeners. Figure 1 illustrates a Versenate Hardness tester. The simplicity of its operation can be judged by the following directions which apply to this instrument.

Following is a table of results for the hardness of water obtained by different persons with the Versenate hardness test using a Model No. 5 Drop-Count Tester. None of the persons had ever seen the test performed before.

This data shows that consistent and accurate results are obtained by different persons, even though none had practiced.

This system has been applied to the determination of total hardness by the Versenate Method, alkalinity, iron, hydrogen sulfide, carbon dioxide and chloride. Figure 2 illustrates a Drop-Count Hardness and Iron combination tester.

TRUE TOTAL HARDNESS
(Grains per gallon)

	A			B			C		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
5.0 grains	4-5	5	4-5	5	5-6	5	5	5	5
20.0 grains	19	21	20	21	21	20	20	20	21
58.3 grains	57	60	57	59	59	57	58	58	57

PRACTICAL HINTS AND KINKS

MOVABLE SCAFFOLD HAS MANY USES

By RICHARD ALLEN

IF YOUR PLANT IS anything like ours there are probably numerous times when a movable type scaffold would come in handy for painting, decorating, plastering, maintenance and other types of work where it is necessary that the employees work in locations that are above floor level. In the past we have had our share of such jobs and we've probably built and taken down enough scaffolds to keep the lumber yard and the carpenters happy.

However, in the last six months we have had no trouble on any jobs where it has been necessary for workers to reach and perform work operations in the high spots of our plant. And we're putting our workers at job level—safely, without erecting costly scaffolds.

This improvement in our operating procedures has been brought about by our use of prefabricated rolling scaffolds that can be erected to fit almost any job condition. These scaffolds are erected from simple easy-to-assemble parts. The end frames (shown in Fig. 1) are joined by pivoted diagonal braces to form the basic unit. Additional frames are placed on top of the original basic unit by means of sprockets.

We have found that on many jobs the rolling scaffolds, connected by trusses, provide a most satisfactory working platform, and are especially useful where intervening equipment or installations must be bridged. Fig. 2 and 3 illustrate two typical methods of using the rolling scaffold. Figure 2 illustrates how the scaffold frame can be fitted with 20 in. or 30 in. end brackets so that the working area is increased in both directions. Shown in the illustration are two end brackets with a platform support. This permits placing planking entirely across the units from one bracket to another.

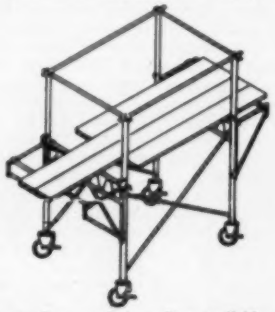


Fig. 2. Frames of the rolling scaffolds can be fitted with 20 in. or 30 in. end brackets supplementing the side-wall brackets so that the working area is increased in both directions. Shown are two end brackets with a platform support. This permits placing planking entirely across the units from one bracket to another

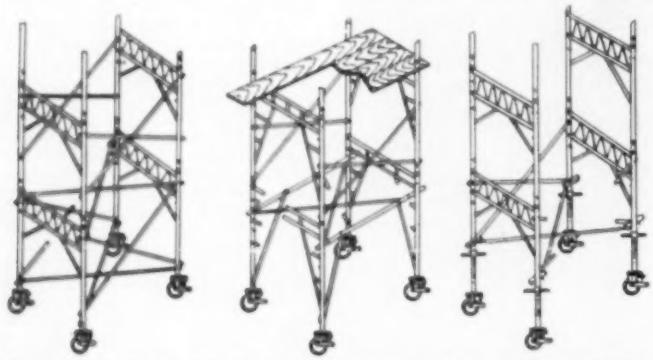


Fig. 1. Three typical installations of the rolling scaffolds. Left illustration shows the deep trussed end frames joined by pivoted diagonal brackets and fitted with casters having 6 in. canvas or steel wheels. Center illustration shows use of bridging trestle which fits end frames of the rolling scaffold and allows maximum clearance under the scaffold for head room or for traveling over obstructions. Right illustration shows use of adjustable extension legs to gain additional height

Figure 3 illustrates that the rolling scaffolds can be joined together with trusses to make individual units that can be moved as one complete scaffold as the work progresses. The trusses make it possible to clear large obstructions, and also are used at the top of a scaffold to provide a base for an additional working platform.

Other than the usual safety precautions to be observed when working above ground level, we have only added two safety rules to be observed while working on the scaffolds; (1) Workmen should never try to pull themselves along while

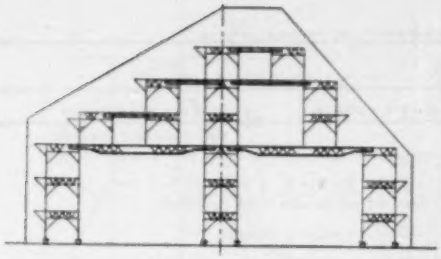


Fig. 3. By joining the rolling scaffolds with trusses, individual units can be moved as one complete scaffold as work progresses. Trusses made it possible to clear large obstructions, and also are used at the top of a scaffold to provide base for an additional working platform

on top of rolling scaffold, and (2) rolling scaffolds should not be erected higher than permitted by governing codes which usually require that the base be approximately one quarter of the height.

ADDITIONAL USES FOR THE HOOK-ON AMMETER

By JESSE F. CLACK

THE JANUARY issue of POWER GENERATION contained an interesting article on the various applications of that very useful instrument, the hook-on ammeter.

One of the applications that was not mentioned and probably not so well known, is that which uses this instrument for the location of grounds, upon faulty circuits.

This use is based on the fact that the algebraic sum of the currents in any balanced three-phase circuit is zero at any given instant, and hence no reading upon the clamp-on ammeter is obtained. If a ground exists however, and the resistance of that ground is low enough to give a reading on the clamp-on ammeter the current flowing in the middle phase destroys the balance that existed when no ground was present upon the circuit.

Should the resistance of the fault be so low that it blows the fuses, you should raise the ohmic value, or increase the resistance of the ground, that has been placed upon the outside wire or phase for test purposes.

The ground test lamp will indicate which wire is grounded, and you may then feed current through a fuse, and load for the test as shown in diagram.

In the event that the circuit is in armored cable or conduit, a test can be obtained in a pull box or at the distributing point. When all grounds are cleared the ammeter will not give a reading, as the circuit is again balanced. The following is an application of an idea somewhat similar to the clamp-on ammeter, and one that will prove quite useful upon occasion.

The sketch (Fig. 2) shows a laminated core that has one end removable, due to the tongue, and groove construction.

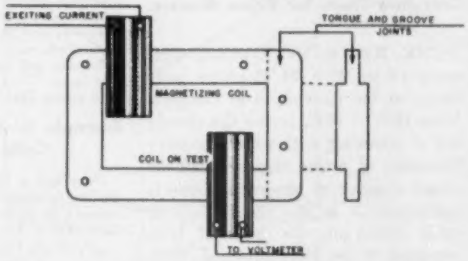


Fig. 2. Details of construction of coil testing device

This core should be approximate in core area the size of most of the coil window holes, or core space of the coils that may have to be tested. Solenoids usually have 115, 230, 460 or 600 volt windings. The laminated core shown in sketch, can be made up from some burned out or discarded windings and cores of small transformers. In the absence of these one can use types of burned out or open circuited potential coils from type I-14 Watthour meters that may be obtained at your local utility electric meter shop. The best accuracy in tests can be obtained by using the same type of coils at the same time.

If it is desired to test a 115-v Coil use a 115-v solenoid also for a magnetizing coil. Assume that a 115-v coil must be replaced, and only a 230-v coil is available.

Place the 115-v magnetizing coil upon the core, and also the 230-v coil. Take a voltmeter reading from the "on test" coil using the 300-v scale on your voltmeter, which should show about 230-v (which is just twice as much as is desired). Remove the 230-v coil from core, and place upon a wooden mandril in a horizontal position in a vise. Remove the outer insulation, and commencing at the outer terminal of the winding, you can in a few minutes reel off one half of the winding taking care not to take off too much wire before slipping the test coil back on the core and taking a voltage reading to see how close you are getting toward your desired 115-v condition. You will find from experience that it is not desirable to bring it down to exactly 115-v as you will find that it will operate perfectly on a reading that gives you, say, 130-v.

Should you desire to know the approximate number of turns in any coil, use a low reading voltmeter (say one that reads to as low as ½ or ¼ volt) and taking any convenient piece of magnet wire 3 or 4 ft long put a piece of paper around core and wind on a few turns of wire (8 or 10) and take a reading and add or subtract turns until it reads 1 volt. Should it take 10 turns, 115x10 equals 1150 turns to give you a 115-v coil.

In this manner you can make up coils of the value desired. In conclusion a few words of caution may prove helpful to some: Never place a solenoid upon the clamp portion of your clamp-on ammeter and energize it; also, do not clamp it around the core of the above device, as the heavy flux will violently slam the pointer against the stops and ruin an expensive and extremely useful instrument.

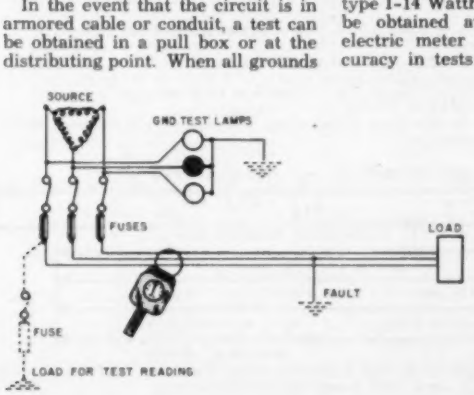


Fig. 1. Showing the use of the hook-on ammeter for locating grounds

WESTERN UNION has recently installed a 3-stage vacuum tube amplifier in one of its Atlantic cables, 200 miles at sea. The equipment is installed in a steel case and lies on the ocean bottom, 1800 ft deep.

Basic Power Plant FIGURING

By WILLIAM H. ENGELMAN

Mechanical Engineer

Department of Water & Light
City of Cleveland, Ohio

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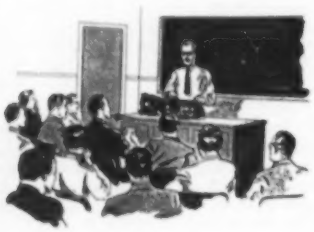
Performance of Steam Turbines and Steam Engines Measured by Actual Thermal Efficiency and Rankine Cycle Efficiency. What These Terms Mean and How to Calculate Them for Prime Movers.

THE RANKINE CYCLE, first analyzed by W. J. M. Rankine, professor at the University of Glasgow from 1820 to 1872, forms the standard of reference with which the performance of prime movers, such as steam engines or steam turbines, is compared. It is the ideal working cycle based on the ratio of heat available to the heat supplied. With no losses, all the Btu, theoretically available in the heat engine, would produce work. This is impossible, hence, the actual work done is always less than the theoretical. The expression for this term is ACTUAL THERMAL EFFICIENCY and is the ratio of heat output to heat input (always a decimal). It serves as a standard guide in the actual performance of a given steam engine or steam turbine.

In the Rankine cycle the steam expands adiabatically, i. e., without gain or loss of heat, usually known as CONSTANT ENTROPY. Expansion or isentropic expansion.



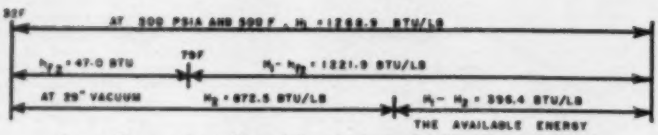

325
AT 200 PSIA AND 500 F. H_1 = 1268.9 BTU/LB
h_{f2} = 47.0 BTU
79F
$H_1 - h_{f2}$ = 1221.9 BTU/LB
AT 29" VACUUM
H_2 = 872.5 BTU/LB
$H_1 - H_2$ = 396.4 BTU/LB
THE AVAILABLE ENERGY

Fig. 1. Diagram for turbine of Example 1, showing heat energy relations

$$\text{Rankine Cycle Efficiency} = \frac{\text{available Btu per lb or adiabatic heat drop}}{\text{total Btu per lb—Btu in the condensate}}$$

$$\text{It is } \frac{\text{available energy}}{\text{heat supplied}} = \frac{H_1 - H_2}{H_1 - h_{f2}} \text{ (always a decimal)}$$

The term RANKINE CYCLE EFFICIENCY RATIO is applied to the ratio of the actual thermal efficiency to the Rankine cycle efficiency. This ratio indicates clearly to what extent the thermal losses have been reduced in the steam engine of steam turbine. It may be written thus:

$$\text{Rankine Cycle Efficiency Ratio is } \frac{\text{actual thermal efficiency}}{\text{Rankine cycle efficiency}} \text{ (always a decimal)}$$

Let: Th E = Thermal efficiency of the actual engine.
R C E = Rankine Cycle Efficiency.
R C E R = Rankine Cycle Efficiency Ratio.
H_1 = enthalpy at the initial pressure under any condition, whether wet, dry-saturated or superheated steam, in Btu per lb.
H_2 = enthalpy of the steam after isentropic expansion from the initial to the final exhaust pressure, in Btu per lb. (constant entropy)
h_{f2} = enthalpy of the liquid or condensate at exhaust pressure, Btu per lb.

One Btu is the equivalent of 778.26 ft-lb and since there are 1,980,000 ft-lb in one horsepower-hour (33,000 × 60) we have:
One hp-hr is the equivalent of 1,980,000 ÷ 778.26 or 2,544.1 Btu per hr.
One kw-hr is the equivalent of 2,656,000 ÷ 778.26 or 3,413.0 Btu per hr.

Problems involving adiabatic expansion may be solved quickly and for most cases sufficiently accurate by the Ellenwood-Mackey *Thermodynamic Charts* or from a large Mollier Chart. They may also be calculated from Keenan & Keyes Steam Tables by using the entropy functions. Both methods will be used in the examples which show complete applications.

Purpose and application of the Ellenwood-Mackey charts were explained in detail in the July issue. These *Thermodynamic Charts* as well as the *Thermodynamic Properties of Steam* (the Steam Tables) are published by John Wiley & Sons, Inc., 440 Fourth Ave., New York.

Example 1:—Thermal Efficiency, Rankine Cycle Efficiency, and Rankine Cycle Efficiency Ratio For a Particular Steam Turbine

On a test, a 10,000-kw turbine generator uses 126,000 lb of steam per hour at full load; the steam pressure is 200 psia, the steam temperature 500 F, and the vacuum is 29.0 in. referred to 30-in. barometer.

Compute: a. The steam rate or water rate.
b. The available Btu or heat drop at constant entropy.
c. The Btu consumed per kwhr.
d. The foot-pounds of work developed for each Btu consumed.
e. The thermal efficiency, Th E.
f. The Rankine Cycle efficiency, R C E.
g. The Rankine Cycle efficiency ratio, R C E R.

Solution:—

a. The steam rate w = 126,000 ÷ 10,000 = 12.6 lb per kwhr.
At 200 psia and 500 F ..... H_1 = 1,268.9 Btu per lb
At 29 in. vac. and const. entropy (1,624) ..... H_2 = 872.5 Btu per lb
b. Difference is the available Btu or drop ..... = 396.4 Btu per lb
Enthalpy in liquid at 29-in. vacuum ..... h_{f2} = 47.0 Btu per lb
c. $w(H_1 - h_{f2}) = 12.6(1,268.9 - 47) = 15,396$ Btu per kwhr.
d. 2,656,000 ÷ 15,396 = 172.5 ft-lb of work developed per Btu consumed.
e. Thermal efficiency Th E = 3413 ÷ 15,396 = 0.2217 or 22.17 per cent.
also Th E = 172.5 ÷ 778.3 = 0.2217 or 22.17 per cent.

f. $$\text{R C E} = \frac{H_1 - H_2}{H_1 - h_{f2}} = \frac{1268.9 - 872.5}{1268.9 - 47.0} = 0.3244 \text{ or } 32.44 \text{ per cent.}$$

g. R C E R = 0.2217 ÷ 0.3244 = 0.6834 or 68.34 per cent.

$$\text{R C E R is also } \frac{0.2217(1268.9 - 47)}{(1268.9 - 872.5)} = 0.6834 \text{ or } 68.34 \text{ per cent.}$$

Values were taken from the Ellenwood-Mackey charts and checked with the large Mollier diagram and the steam tables.

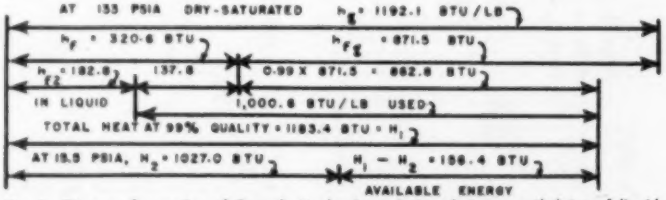

AT 135 PSIA DRY-SATURATED h_g = 1192.1 BTU/LB
h_f = 320.6 BTU
h_{fg} = 871.5 BTU
h_{f2} = 182.8
137.8
0.99 X 871.5 = 862.8 BTU
IN LIQUID
1,000.8 BTU/LB USED
TOTAL HEAT AT 99% QUALITY = 1183.4 BTU = H_1
AT 15.9 PSIA, H_2 = 1027.0 BTU
$H_1 - H_2$ = 156.4 BTU
AVAILABLE ENERGY

Fig. 2. Diagram for engine of Example 2, showing relations between enthalpies of liquid and vapor, total energy and available energy

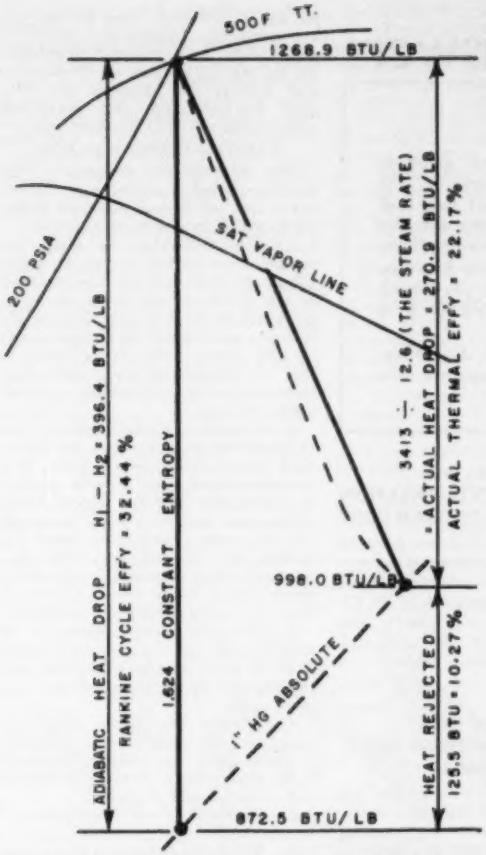


Fig. 3. Simplified Mollier diagram for turbine of Example 1 and Fig. 1. Shows adiabatic and actual expansion lines. In the actual turbine the expansion line is usually more like that shown as a dotted line, coming down straighter and curving a bit at the bottom. However, for most practical work on medium-sized turbines and for low and medium pressures, it is sufficiently accurate to consider the actual expansion line a straight line. They both end at the same point of heat energy, entropy and moisture on the Mollier chart.

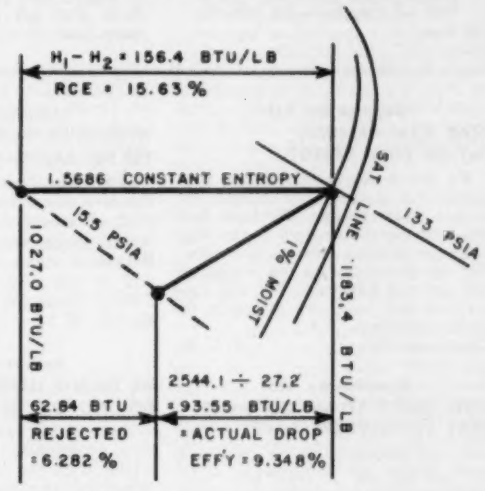


Fig. 4. Simplified Mollier diagram showing adiabatic and actual expansion lines for engine of Example 2 and Fig. 2

Example 2:—Thermal and Rankine Cycle Efficiency for a Steam Engine

A steam engine develops 27 i.h.p., (indicated hp) and uses 734.4 lb of steam per hour at 133 psia and 99 per cent quality. The exhaust pressure is 15.5 psia.

Compute: a. The steam or water rate per i.h.p.-hr.
b. The available Btu or enthalpy drop at constant entropy.
c. The Btu consumed per i.h.p.-rd.
d. The foot-pounds of work developed for each Btu consumed.
e. The thermal efficiency, Th E.
f. The Rankine cycle efficiency, R C E.
g. The Rankine cycle efficiency ratio, R C E R.

a. The steam rate $w = 734.4 \div 27 = 27.2$ lb per ihp-hr.
At 133 psia and 99 per cent quality ..... $H_1 = 1{,}183.4$ Btu per lb
At 15.5 psia exhaust, 1.5686 constant entropy ..... $H_2 = 1{,}027.0$ Btu per lb
b. Difference is available Btu or drop ..... $= 156.4$ Btu per lb
Enthalpy in liquid at 15.5 psia ..... $h_{f2} = 182.8$ Btu per lb
c. $w(H_1 - h_{f2} = 27.2(1183.4 - 182.8 = 27.216$ Btu per ihp-hr.
d. $1{,}980{,}000/27{,}216 = 72.75$ ft-lb of work developed per Btu consumed.
e. Thermal efficiency Th E $= 2544.1 \div 27.216 = 0.09348$ or 9.348 per cent.
also Th E $= 72.75 \div 778.26 = 0.09348$ or 9.348 per cent.

f. $$R\,C\,E = \frac{H_1 - H_2}{H_1 - h_{f2}} = \frac{1183.4 - 1027}{1183.4 - 182.8} = 0.1563 \text{ or } 15.63 \text{ per cent.}$$

g. $$R\,C\,E\,R = \frac{\text{Thermal efficiency}}{\text{Rankine cycle efficiency}} = \frac{0.09348}{0.1563} = 0.5981 \text{ or } 59.81 \text{ per cent.}$$

also $$\frac{0.09348(1183.4 - 182.8)}{(1183.4 - 1027)} = \frac{93.536}{156.4} = 0.5981 \text{ or } 59.81 \text{ per cent.}$$

Computing the exhaust steam conditon at 15.5 psia with the entropy functions, we have:

Constant Entropy—1.5686 — 1.5686
s_f —0.3160 — —0.3160
s_{fg}—1.4364 — 1.2526 ÷ 1.4364 = 0.872 or 87.2% quality.
h_f —182.70 Btu — $X \times h_{fg} = 0.872 \times 968.6 = 844.6$ Btu per lb
h_{fg}—968.60 Btu — adding $h_f = 182.7$ Btu per lb
Enthalpy in exaust is 1027.3 Btu per lb (12.8% moisture)

CHEMISTS GIVE INDUSTRY NEW FROZEN BOLT LOOSENER

By MYRTLE SHAFER

As a result of new chemical discoveries a big job had been made into a little one. It is now possible to loosen frozen bolts, nuts, pipe threads, and other corroded metal joints that formerly resisted the best tools man could develop and the hottest words that could be spoken.

This latest helper from the labs has proved that it will pass through openings as small as one-millionth of an inch and dissolve rust, dried grease and gummed oils and provide lubrication which permits the parts to be separated without damage. I don't know how many hours this product has saved our boys, but I do know it has become a valuable item in most of the tool kits and a frozen joint doesn't cause bluer-than-blue words. Our new helper is called "Krano-Kroil." Might remember the name the next time you've got a bolt the Devil himself couldn't jar loose.

Questions and Answers

Q & A—THE POWER ENGINEER'S FORUM—HERE'S HOW IT WORKS

YOUR QUESTION about some problem in operation, maintenance or design will be published, signed only with your initials.

Answers to your question from other readers will be sent you as soon as received, then published as space permits, so that all may have the information.

You, too, answer questions from other engineers in the same way. You get paid well for published answers and also get the credit for knowing them.

If other engineers help you solve your problem, you express your thanks, via the Q & A editor.

Simple, isn't it? And effective! Just ask engineers who have tried it!

Question No. 467

HOW CAN HE LIMIT DUPLEX PUMP SPEED?

WE ARE in search of a device that limits the strokes per minute of duplex steam pumps. We have had two such units damaged in the past year due to high speeds. Pressure-limiting governors on the discharge end are not effective. We will appreciate any lead you can give us on this problem.

Cincinnati, Ohio F. L. S.

Question No. 466

HOW MUCH STEAM DO THESE HEAT EXCHANGERS SAVE?

IN OUR FINISHING PLANT, we heat wash water for continuous cloth washers. The hot water overflows continuously. For some years we have been wasting this hot wash water. Now we have installed heat exchangers to reclaim heat from the wash water to heat incoming fresh water. We now want to figure how much steam we are saving by using heat exchangers.

Water in the wash boxes is heated by live saturated steam at 100 psig. The waste water enters the heat exchangers at 150 F. The fresh water enters the heat exchangers at 58 F. The fresh water leaves the heat exchangers at 100 F. The flow of fresh water is 1500 gpm. The fresh water is heated from 100 F to any required temperature with live steam in the wash boxes. Our steam is metered at 200 psig.

We have been using the following formula for figuring the amount of steam saved by our heat exchanger installation.

$$\frac{\text{Gpm fresh water} \times 8.33 \times 60 \times \text{Deg F rise in temp}}{\text{total heat of steam at 200 psig}} = \text{lb steam saved per hr}$$

$$\frac{1500 \times 8.33 \times 60 \times 42}{1198.7} = \text{26,400 lb steam at 200 psig saved per hr. by heat exchangers.}$$

Is this formula correct?

South Carolina H.A.W.

Question No. 468

WHAT IS RATE OF CONDENSATION PER SQUARE FOOT OF STEAM COIL?

WILL YOU please tell me what is the rate of condensation per square foot of steam coil submerged in water whose temperature is 60 F? Saturated steam is supplied to the coil at 135 psig, or 150 psia and 358.4 F (from the steam tables).

Buffalo, N. Y. V. L. G.

Answer No. 462

HE WANTS INSTRUCTIONS FOR BOILING OUT A BOILER

WELL, E.S.N., you've really got 'em now, as requested in the June issue. Along with the question, we published the latest and best instructions we could find, taken from the recent and authoritative book *Combustion Engineering*.

Now, all the brethren agreed that those instructions are perfectly all right, and they especially commended the editors' comments on proprietary boiling-out compounds and the caution to consult your own water treatment chemist on the proper method to use in your particular case.

But look how the brethren rallied round to remind you of little details in boiling-out that you'd never get except from actual practice or successful experience with little tricks of the trade.

For example, one engineer very effectively uses good old Fels-Naphtha soap as one of his boiling-out ingredients. Another has some comments on how to use the surface blow-down. Also, be sure you don't let any of the dirt bake on as you are draining. Important:—if it's a new boiler, have trained operators for boiling out because all auxiliaries and fittings and controls are still new and untuned, and operating procedures not yet standardized.

Additional Pointers from Poor

THE BOILING-OUT procedure the editors quoted is a good one. There are a few additional pointers, however, which might be mentioned.

1:—The difference between the temperature of the water used for filling the unit and the temperature of the drum should be as small as possible, preferably less than 50 F; filling a cold boiler with hot water, or vice versa, will set up stresses due to differential expansion that may cause tube seat leakage or cause other damage.

2:—Chemical concentrations two to three times the one part per thousand quoted are preferred; the low concentrations save a little money on chemicals, but the higher concentrations will do a more thorough job and may prevent the need for boiling out a second time, with consequent labor charges and costly delay many times more expensive than the small savings in chemicals.

3:—For the same reason, it is wise to boil out about 48 hr instead of 24. A pressure approximately half the normal operating pressure is a good value.

4:—During the early stages of operation, the water level visibility is particularly important; therefore, if the gage glass is dirty after boiling out, clean it and repack it.

5:—The boiling out process should be entrusted only to *trained operators*. When equipment is first fired up it is untried; meters, controls, and interlocks may not function properly; auxiliaries are subject to unexpected failure; operating procedures are as yet unstandardized; and, in general, operation is less reliable and more hazardous than during the subsequent normal life of the unit.

New York, N. Y. HUSTACE H. POOR

More Details from Experience of H. D. Fisher

THE REPLY to this question in June covers the ground adequately, but I should like to add a few details I have found useful.

1:—It is an excellent idea to specify that boiler tubes shall not be oiled inside, also that only lubricants which can be emulsified readily shall be used in any work on the interior of the boiler. Soft soap makes a good lubricant for expanders and proprietary compounds are also available.

2:—Obtain from the boiler manufacturer the water content of the boiler to operating level.

3:—As recommended by the Editor, consult your water treatment chemist and obtain a formula for the boiling out mixture. Anyway, get a

recipe from some competent authority.

4:—Make a flattened conical sheet iron funnel with an elliptical mouth about 24 in. by 12 in. high and locate it with the axis of the cone horizontal and about at operating water level and pipe it up to the continuous blowdown connection to serve as a surface blow. Mark the level of the center line of the funnel on the water column.

5:—Clean out everything loose in the boiler, wipe it out as well as possible and close it up.

6:—Fill the boiler nearly to operating level, dissolve the proper amount of chemicals in water in a drum and drain it into the boiler drum, through any convenient connection on top of the drum.

Then, depending on whether the operation is to be a combined setting drying and boiling out, or a simple boiler out, procedures vary slightly.

If the setting is to be dried out, the rate of heating will be governed by that and will be considerably slower. I have, as a rule, carried a low but gradually increasing fire for four or five days before generating any considerable amount of steam, regulating the fire by the rate of rise of temperature of the brickwork as indicated by thermometers set in sleeves in the boiler wall.

Once the pressure begins to rise it comes up rather quickly and a period of 24 to 36 hr boiling out at 30 to 50 lb is usually ample. The surface blow should be used every four hours or so until it blows clean. In this way quite a bit of froth and dirt, which would coat the drums and tubes when the boiler is drained, is disposed of.

When the setting is properly dried out, allow it to cool sufficiently that its heat will not dry dirt onto the interior of the boiler when it is drained. Drain the boiler. Take off a manhole cover and such handhole covers as necessary to wash down the interior and flush the boiler out thoroughly.

If you have had proper advice and a formula containing emulsifying and wetting agents the boiler should be clean. If any traces of grease show on the plates, however, the process should be repeated, though in this case, as stated in *Combustion Engineering*, the pressure can be brought up in four to six hours and again held at 30 to 50 lb for 24 to 36 hr.

If, however, the repairs have been to the boiler only and no new brick work has to be dried out, steam can be brought up promptly as just described for reboiling out.

The points I would emphasize to make the job as easy as possible:

1. Get a minimum of grease into the boiler.
2. Get competent advice as to the chemicals best suited to your water conditions.
3. Get rid of all the muck you can with the surface blow.
4. Don't let the dirt deposited on the boiler surfaces bake on while draining the boiler.

New Haven 15, Conn. H. D. FISHER

Green Adds Soap and Kerosene to the Soda Ash

ON HOW to boil-out a boiler, I am submitting the following procedure I have used for a number of years to advantage on 14 boilers here in Trona, Calif. These are B.&W. water-tube boilers, Stirling type, equipped with waterwalls and economizers; steam capacity of 150,000 to 200,000 lb of steam per hour each.

For this process, a chemical charge of 800 lb of soda ash (½ lb per bhp) and 100 gal kerosene (1 gal for each 15 bhp) and 2 cases (96 bars) Fels Naphtha soap cut into 8 pieces (48 bars per 700 bhp). Boil at 75 to 100 psi for 36 hr.

After the boiler comes off the line, let it cool down slowly until pressure is at zero, open blowdown valves and drain down to just below the manhole cover on the mud drum. Open drum and add chemical charge, fill mud drum with hot condensate to bottom of manhole, seal up mud drum and turn on the steam. As soon as all the air has been dispelled from the boiler drums and superheater, close the vent valves.

Now let the pressure in the boiler rise to around 75 psi. Then start the induced-draft fan to control the pressure in the boiler by operating the dampers. Watch the amperage on the I.D. fan motor so that you won't pull an overload on the motor due to the cool air the fan is handling. About one-half the amount the fan usually handles. Every 3 hr, open the boiler drum and superheater vent valves wide open for 5 min to dispel the air that is in the water.

After 14 to 16 hr, fill the boiler to ¾ of a glass with hot condensate through the drum vent valve. Now the boiler should be starting to skim over through the economizer. Regulate the level in the drum by the amount of blowdown through the economizer blowdown valve to maintain ¾ of a glass in the boiler at all times during the boiling-out period.

After 18 to 20 hr of skimming over, shut the steam off the boiler and keep the induced-draft fan running to cool the boiler down. When the pressure in the boiler drops to 20-25 psi, open the drum blowdown

"Yuh'd think them enJineers would allow fer a little heat loss here in the boiler room at least!"

valves; and the water-wall blowdown valves should be opened at about 15 psi.

Allow the boiler to drain dry or until pressure reaches zero. Now open the steam drums and wash them out with hot condensate and then open the manhole cover on the mud-drum and wash that out also with hot condensate. Open a few handhole plates on both top and bottom water-wall headers (both sides) and wash the headers down with hot condensate. Now, after the boiler settings and drums cool down, you are ready to turbine the tubes and buff the drums, and be ready for the boiler inspector.

The boiling-out piping takes off a 165-lb steam line and connected to each end of the mud-drum through the regular top blowdown valve. Bottom blowdown valve removed and blanked off also connected to the 3 bottom water-wall blowdown connections, the outside blowdown valve removed and blanked off. This way it gives you a good steam flow through all parts of the boiler.

The economizer skim-over line is connected to the blowdown valve and reduced down to a 1-in. line with a globe valve attached to same for good regulation, the economizer blowdown valve removed and line blanked off.

I have used caustic soda and tri-sodium phosphate as a chemical charge for boiling out boilers but I've had better results from the foregoing solutions, also the men complained of burns and itching due to the caustic adhering to the drums. It also wore out the men's clothing very fast. I still do not know why the Fels Naphtha soap and the kerosene work so well together but the results are very good, a lot more so than the solution of tri-sodium phosphate and kerosene, or caustic soda and soda ash.

I hope E.N.S. will give the above solution a try. I sincerely believe he will be amazed at the results, and I highly recommend it to all other engineers who have a lot of oil and grease getting into their boilers.

Trona, Calif. SAMUEL R. GREEN

Answer No. 464

IS HIS SUBSTATION GROUND GOOD?—AND HOW CAN HE TELL?

THEY HAD quite a bit of trouble with lightning last summer, reported A.D.A. in the June issue, and were advised to check their substation ground with an ohmmeter. The ground bus is connected to heavy cables that run out to the bed of a nearby creek.

For various reasons they did not make this test but now want to do so; but are not sure just how to do it. How can they determine whether a ground is good or not?

Between what points should an ohmmeter be connected?

Three Methods Available, says Kane

GROUNDS should be tested at least once a year by one of three methods.

a. The megger ground tester.
b. The fuse procedure.
c. The voltmeter-ammeter method.

The megger ground instrument has been designed for this purpose and is the easiest and simplest, and gives direct readings in ohms. The manufacturer provides an instruction book, which is comprehensive and gives complete information regarding the use of the instrument and how to hook it up.

In the fuse application, a grounded a-c 110-v circuit should be provided, with a 20-amp fuse placed in the ungrounded section of the circuit, which is hooked to the ground being checked. If the fuse ruptures when the switch is energized the ground resistance should be within satisfactory limits, or 5 ohms or lower.

The voltmeter-ammeter method is accurate, but slow. It is somewhat complicated, which more or less rules it out if a megger ground test set is available or can be obtained.

Generally speaking, the resistance of grounds should not exceed 5 ohms.

West Medford, Mass. A. B. KANE

Use Voltmeter, Ammeter and Temporary Grounds, says Bookwalter

TO CHECK his station ground, a special instrument is available for this purpose, but A.D.A. can check it by using an a-c voltmeter, a-c ammeter, and a source of low voltage ungrounded a-c, as shown in Fig. 1, as follows:

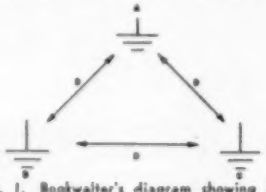


Fig. 1. Bookwalter's diagram showing how to locate auxiliary or temporary grounds to test permanent ground

A is the permanent ground. B and C are temporary grounds consisting of short pieces of pipe or rod. Distance D should be at least 15 ft.

Hook up the transformer, meters, and grounds as shown in Fig. 2.

Take voltage and current readings for each of the three conditions. Voltage and temporary grounds or both may be varied to give usable readings with the meters available. Solve for resistance in ohms of each of the three set-ups as follows:

$$R_{ab} = \frac{V_{ab}}{I_{ab}}$$

$$R_{ac} = \frac{V_{ac}}{I_{ac}}$$

$$R_{bc} = \frac{V_{bc}}{I_{bc}}$$

The resistance of the permanent ground is then determined as follows:

$$R_a = \frac{R_{ab} - R_{bc} + R_{ac}}{2}$$

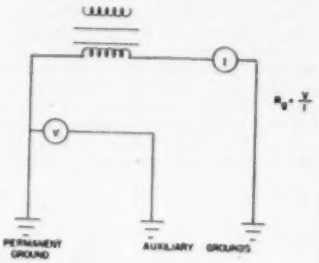


Fig. 3. Here is a simpler hook-up, but not quite so accurate, says Bookwalter

Another method, which is somewhat simpler but not quite so reliable as the above, is shown in Fig. 3. In this case, resistance to ground

$$R_{ac} = \frac{V}{I}$$

In both methods the voltage source must be ungrounded. Also, d-c should not be used, as it will give misleading results due to the effects of electrolysis. The ground should be disconnected from the system while testing.

Middletown, Ohio ROBERT L. BOOKWALTER

Comments by von Donnenberg

VALUE of the resistance of a ground must be measured in relation to certain reference stations. There are available, in practical form, so-called "bridge" devices which will give the information required, without calculation. Concerns selling lightning arresters will give this information. Among these

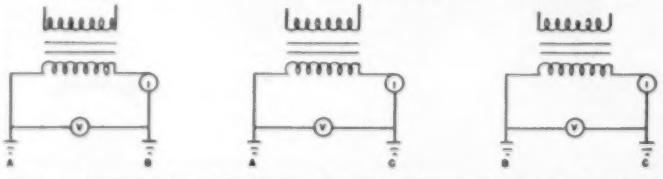


Fig. 2. Bookwalter's diagram showing how to connect voltmeter and ammeter in each of ground circuits

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are the Borden ground tester sold through many local manufacturers and quite inexpensive.

To answer the question more specifically, the type of installation, including its equipment, must be known and it can be stated at once there must never be less than two separate grounds or grounding groups, and preferably more than two groups. This will make possible the temporary disconnection of one ground connection at a time for testing purposes, without completely isolating from ground the equipment being protected.

The questioner states " . . . quite a bit of trouble . . . " without further detail, so it might be assumed equipment was damaged.

Using an ohmmeter or similar device, it is necessary first to add additional test ground points using driven pipe or rod, as in the diagram Fig. 4 and then disconnect the ground point or group under test from all its apparatus or station connections.

Referring to Fig. 4, G is the ground to be tested while t_1 and t_2 are the auxiliary test points for determining, through measurement, the value of the resistance of G to ground. With an ohmmeter or other equipment, then measure three sets of resistance values as follows:

From t_1 to G, calling it "a"
From t_2 to G, calling it "b"
From t_1 to t_2, calling it "c"

Inserting the values of a, b and c, obtained by test, in the formula:

$$G = \frac{a + b - c}{2}$$

we get the value desired. The test is so simple it can be made faster than described. Use a-c or varying d-c.

Just what value G should be cannot be stated definitely; but experience indicates values of less than 10 ohms and if possible, less than that; values of the order of 1 and 2 ohms

Fig. 4. Diagram by von Dannenberg showing use of auxiliary grounds for testing

are desirable. This detail is not a simple one and must be coordinated with the features of the equipment being protected in their electrical characteristics.

Ground points should cover a wider area and copper weld rods driven at intervals of 25 ft to a depth of 10 ft or more will aid in reducing the total ground resistance. The expense of lowering the ground connection resistance by installing more points, plus the interconnecting system, is so low compared to cost of apparatus failure and loss of revenue through interruption of service, plus public relations, that it will more than pay dividends from every standpoint.

The questioner is referred to very comprehensive information on the subject of grounding, installing and maintaining it, published by lightning arrester manufacturers and by the Superintendent of Documents, Washington, D. C.

Brooklyn, N. Y.

C. O. VON DANNENBERG

Answer No. 465

HOW CAN SOLDER BE COLORED SAME AS METAL USED ON?

SOME TIME AGO we published a little article telling what chemicals to put in solder to give it the same color as copper or brass. F. J. M. said he had had a clipping of it, but lost it. Now he needs to have this information again. Could we find it for him or can Q & A readers give any information on it?

Editor's note:—Yes, we have some information on it, also a comment from a reader.

THERE ARE various ways in which solder can be made that will have colors similar to the metals they are used with.

When brass articles are soft-soldered, the white color of the solder contrasts unpleasantly with the brass. If this is objected to, the soldered part can be colored yellow in the following manner.

Dissolve 10 parts of copper sulphate in 35 parts of water. Stir with a clean iron wire and apply the solution to the solder. This gives the part the appearance of copper.

To produce the yellow color, paint the part with a mixture consisting of one part of a solution of equal parts of zinc and water (one part each), and two parts of a solution of 10 to 35 parts respectively of copper sulphate and water and rub on with a zinc rod. The resulting yellow color can, if desired be improved by careful polishing.

Note that this is only a method for coloring solder. If you want a solder which will have the color of the copper which you desire, you can make a good copper solder as follows:

The most commonly employed copper solder can be made up of five parts of copper and one part of lead.

By increasing the quantity of lead, the fusibility of the solder is increased, but the mixture departs from the color and the toughness of the copper.

For red copper, use three parts of copper and one part of zinc.

Freyberg Also Recommends Copper Sulphate

WHAT F. J. M. is looking for is the fact that blue vitriol, properly applied, will cause a thin film of copper to be deposited on the solder used to make the joint. All the flux used in the soldering must be removed from the solder and the copper. Then blue vitriol is applied so that it touches the copper next to the solder, and the copper deposit appears on the solder.

Though sometimes successful, it is risky to apply a second coating of the blue vitriol, and with a third application in the hope of making the copper deposit heavier, the solder will surely turn black.

This is an old method used by sheet-metal men. They used to say that the copper coating deposited with one application would endure until the bill was paid. The dark oxide of the solder will show through in a short time.

Copper or brass work which must be free from showing solder should be brazed. If soldered, it should be done in the inner or reverse side so that only that portion which may have sweated through need be removed by scraping and sandpaper.

F. J. M. may need to know that "blue vitriol" is hydrous copper sulphate.

Pleasantville, New York

RICHARD H. FREYBERG

LETTERS TO THE EDITORS

(Continued from page 53)

essentially to the auto-transformer and not to the main bank where its effect creates an undesirable element. In the past, attempts were made when some one-phase 115 volt capacity was required from a 3-phase 230 volt bank to tap the center point of one winding as shown in Fig. 2. Such an arrangement resulted in bad operation with appreciable 3-phase and one-phase load on the bank.

The discussion of simultaneous one-phase and 3-phase loads has been most thoroughly reviewed in

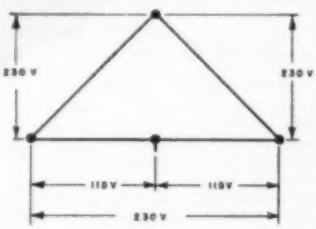


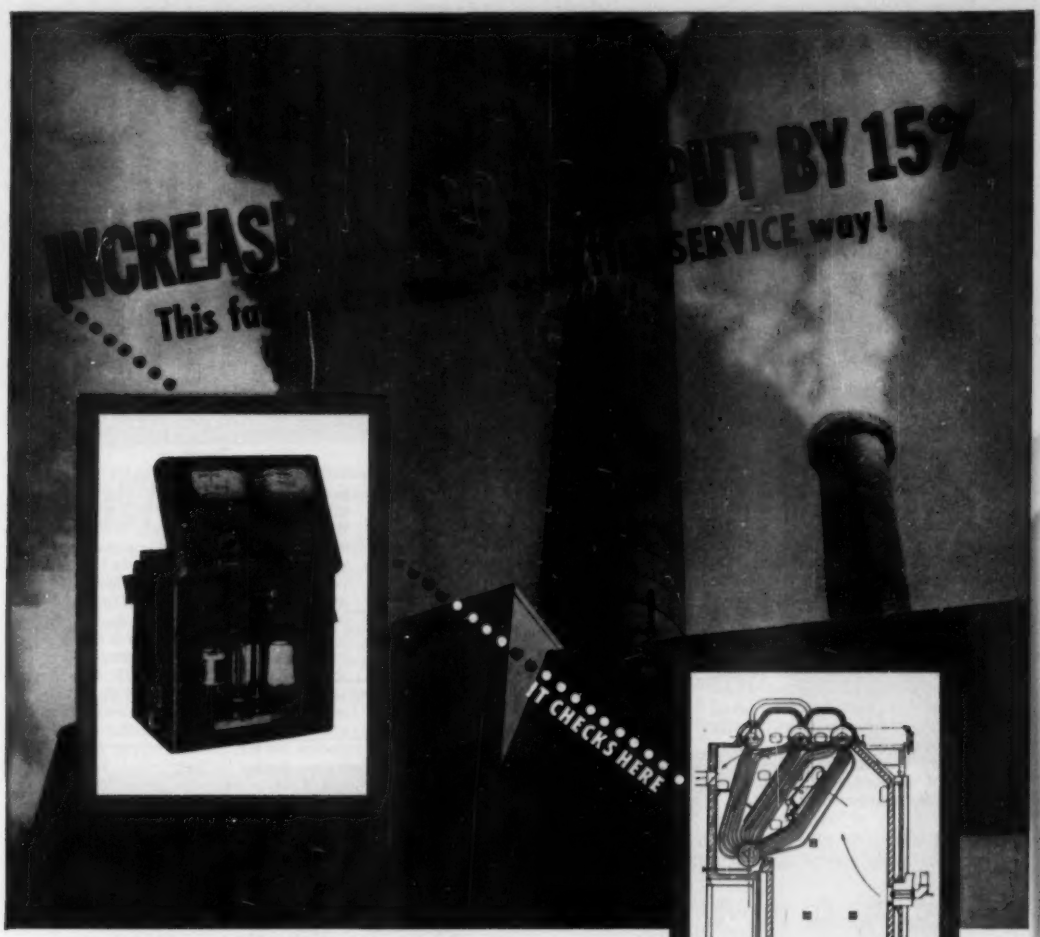
Fig. 2

past issues of *Power Plant Engineering* and most completely in an article in the General Electric Review, October 1934 by M. F. Beavers.

It should always be borne in mind that a one-phase load fed from a 3-phase bank even if completely one-phase, results on the high voltage side of a 2/3, 1/2 and 1/3 current division.

Brooklyn, N. Y.

C. O. VON DANNENBERG



The Cities Service Industrial Heat Prover

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Operation POWER FACTOR

A new approach to an old subject. Maybe you know all about power factor, what it does when it is low and what you can do about it. Even so, maybe this will help you explain it to the Old Man so that he will OK your plea for a few synchronous motors strategically located to improve your power factor

By D. G. MAXWELL Engineering Department, Electric Machinery Mfg. Co., Minneapolis, Minn.

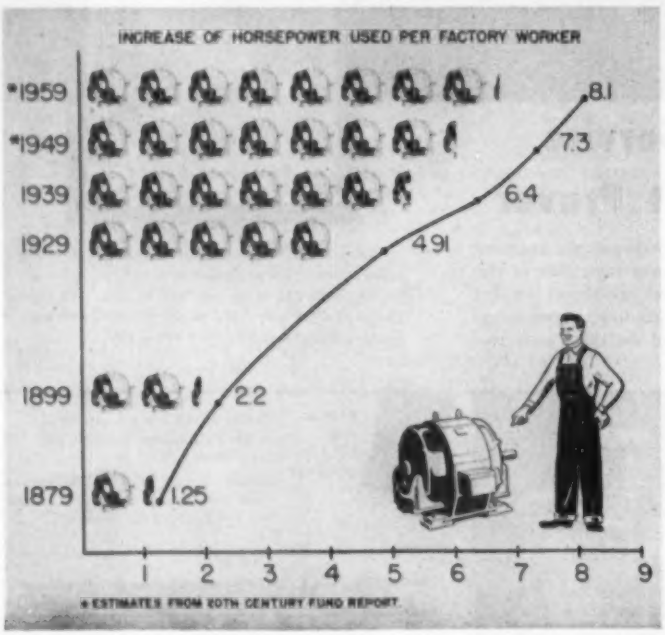
THE AMBITIOUS junior engineer, trying to make good in a hurry, burst into his chief with, "Here are seven points we must check in our plant to see if we can improve power factor and take care of the VP's order to cut our production costs.

"Yes", said the chief, not too interested, "I've heard all about the froth on the beer story, the horse pulling the old-fashioned horse car, and the gremlin Mr. Lowe P. Eff, and I know exactly what power factor is."

"Good", interrupted the junior, sensing the brush-off and not wishing to see his ambitions whisked away so easily, "then you will really be interested in seeing what I have to show you. Look at the increase in the use of motors per production worker in factories—such as ours.

"The picture of the overall increase in industry becomes more amazing if we consider there are now about 12,000,000 factory production workers," continued our ambitious friend. "Also by far the major part of this vast number of motors used is made up of the general-purpose type of motor—the induction motor. And," he said, withholding the doubt from his voice, "since you know all about power factor you are aware that this type of motor is the most prevalent cause of low power factor conditions."

The old man's lack of interest began to disappear as he digested these figures of horsepower used and his previous knowledge of how low power factor increased power bills and reduced plant efficiency. "What are those points to investigate in improving power factor?"



Increase of horsepower used per factory worker

His young assistant warmed up to his opportunity and began pouring out the data.

Point 1

"The first thing to realize is that power companies must impose penalties for low power factor since this condition overloads their generators and lines and causes lower voltage regulation. Someone must pay for this waste—whether it is avoidable or otherwise. The power company's kilowatt-hour meter registers the energy, for which the billing is made for power consumed by the loads in our plants. In addition to the kilowatt-hour charge, the majority of power companies have also incorporated penalties for low power factor, or incentives for high power factor in their rates. We must see if we are paying penalties needlessly or are passing up our share of reduction in rates."

"We paid a penalty of $520.00 on last month's power bill," the chief recalled bitterly.

Point 2

"That brings us to the next point—How is our plant power factor determined for power billing purposes? Here are four of the most common:

(1) Power Factor meter—indicating or recording.
(2) Ammeter, voltmeter, wattmeter method.
(3) Kvar meter and watthour meter.
(4) Reactive kvar meter and watthour meter.

The old man checked the contract file and found that the power company used a recording power factor meter and that billing was based on power factor at the time of maximum demand which was simultaneously recorded on a graphic watthour meter.

"But where is it measured?"

"We buy power at 6600 v and step it down through a bank of transformers to 2200 v. The metering is done on the low side of the transformers."

"Now we're getting places," said the assistant. "You see we are paying for the excitation current in the bank of transformers. Perhaps it would be cheaper to supply mag-

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netizing current, at our own plant—we would also reduce transformer losses in this way, and cut down on required capacity. Another item—one which has to do with our plant expansion—perhaps we should install two additional banks of lower capacity than the one big bank we had planned."

"So far you have told me nothing," the chief said, once again feeling low power factor was an evil of his plant for which no one had a cure.

POINT 3

"Yes, and there is more we must find out before we can figure the proper method to improve our plant power factor. What are the variations in load and power factor? Is the lowest power factor at average or peak load? If the lowest power factor occurs at light loads it indicates that there may be a possibility of rearranging our loading to keep our induction motors more nearly loaded. If power factor is lowest when all induction motors are on the line and fully loaded—perhaps we can use synchronous motors or capacitors."

"I don't know" the chief replied, "but the charts from the recording power factor meter and the graphic watthour meter for years are still on file. Suppose you do some checking for me and let me know just what is the situation that is responsible for our lowest power factor reading."

One week later the chief's assistant walked in and said, "Well boss, here are the statistics on the power factor condition in our plant."

"Good," said his boss, somewhat more enthusiastically than at the beginning of the previous meeting.

"Our lowest power factor reading of the month has for several months been hovering about 70 per cent. This condition appears during the morning when many of our main machines are running lightly loaded."

"But our billing is based on our power factor at maximum demand. How can improving our power factor help us if our lowest power factor occurs at light loads?"

"I also checked the loading of the motors during the whole of the past week. I find that even during our busiest time in the afternoon many of our motors are running partly loaded. Therefore our plant power factor is always lower than it needs to be. The motors are too big for their job. The equipment they drive is overloaded and the motors are still only partly loaded."

POINT 4

"Well, what do you suggest?" queried the chief.

"There are a number of power factor correcting devices. A capacitor is a static device which can be located near the motor load and provides locally the magnetizing current. This eliminates the need of drawing magnetizing current from the power company and relieves the feeders for more watts load. If the load consists largely of groups of small induction motors, and if overmotoring has been avoided, it is probable that capacitors will be the most economical type of power factor correction. A synchronous condenser is a rotating device which serves the same purpose as a static capacitor. It has essentially the same construction as a synchronous motor. However the shaft and bearing requirements are different, since the machine does not deliver power from its shaft. In addition to power factor correction a synchronous condenser reduces voltage fluctuations on the system to which it is connected. Such machines are generally used on large power systems for the regulation of voltage at the receiving stations. A synchronous motor does the double duty of improving power factor while it drives a load. This type represents the corrective device we should use in our plant."

"But you say we already have more motors than we need."

"Not more motors, but in some places, bigger ones than we need," the assistant corrected. "And I had in mind, suggesting some rearranging. With our plant expansion, we will need additional motors.

POINT 5

"Synchronous motors are suitable for practically all drives. Our crushers and compressors are 'naturals' for synchronous motor drives. And there are other drives where synchronous motors are advantageous—pumps, fans, blowers, motor-generator sets, beaters, jordans, chippers and line drives."

POINT 6

"How is this synchronous motor different from the induction motors we now have in our plants?"

The younger man tackled this question with enthusiasm, "Like the induction motor, the stator windings of the synchronous motor are energized from the a-c power supply. Unlike the induction motor however, the rotor of the synchronous motor is also energized. The rotor instead of having a smooth cylindrical shape like the induction motor rotor, has an even number of projecting field poles each wound with a coil. These field poles are excited by direct current.

"This excited rotor is the main difference in construction, and gives the big difference in operation. Having its own basic source of excitation the synchronous motor unlike the induction motor, does not require magnetism from the a-c power line. Furthermore, when 'over-excited,' the synchronous motor supplies an excess magnetism which helps handle the magnetization requirements of induction motors.

"Synchronous motors are inherently simple, compact and efficient."

POINT 7

"What about the cost of these synchronous motors?"

"In figuring the cost we must consider the original investment, the cost of operation and the returns from synchronous motors. Concerning the original investment synchronous motors cost more only in the smaller horse-power sizes at high speeds. Slow-speed, and large high-speed synchronous motors actually cost less than induction motors. Synchronous motors cost less to operate since they are more efficient and their simplicity leads to reduced maintenance costs.

"Next consider the returns we might get from synchronous motors. There will be reduced power billings from improved power factor. There will also be released capacity, since some of the magnetization required will be supplied on the spot. There will be reduced line losses due to less heating through less magnetization current in the lines. This results too in less line drop and better voltage regulation.

"So at the time of our plant expansion we should consider buying some synchronous motors to supply magnetization current as well as drive some load and rearranging our present induction motors so that they will be more fully loaded and operate on improved power factor."

"Sounds good to me," said the chief, "but keep your figures handy, I intend to call on you for help when I discuss this with the Old Man."

WASHINGTON WATER POWER CO. WINS COFFIN AWARD

THE WASHINGTON WATER POWER Co., Spokane, Wash., was presented the General Electric Company's Charles A. Coffin award for outstanding achievement during 1949, at the Edison Electric Institute's annual convention held recently in Atlantic City.

The Coffin award, the electrical industry's highest honor to a privately-owned electric utility, was presented to Kinsey M. Robinson, president of the Washington Water Power Company, by Ralph J. Cordiner, executive vice president of General Electric. The utility was selected by a committee appointed by the E.E.I., which considered 34 companies nominated to receive the honor.

In winning the Coffin award this year, Washington Water Power Company became the first company in the 28-year history of the award to be honored for the second time, having previously won the award in 1940.

Announcing the award winner, Elmer L. Lindseth, president of the E.E.I., stated that the Washington Water Power Company was selected for the honor on the basis of its "well-conceived and superbly-executed 'Better Service Program,' and for its highly-successful efforts to win new friends in the area it serves."

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Atomic Energy's Place in Your Plans for the Future

An accurate and authentic explanation of the present state of atomic energy development with respect to its use for power development as presented by the Vice President in Charge of Engineering of G. E. in the *General Electric Review*

By HARRY A. WINNE

HERE are a few fundamental facts that may help in gaining a little better picture of how atomic energy may possibly, or even probably, enter into the future of the electric-power industry.

Unfortunately, there seems to be no possibility of direct conversion from the splitting atom to electric power. The usable energy released in an atomic pile is in the form of heat. Just as the heat generated in the combustion space in an oil-fired boiler is carried away by the steam, so the heat released in an atomic pile must be carried away by a heat-transfer medium, such as a gas or a liquid.

It is not practical to generate steam within the pile itself, for two main reasons. First, the steam leaving the pile would be radioactive, and consequently the turbine, condenser, and all piping would need heavy shielding. Second, fluctuations in the water level would disturb the nuclear equilibrium within the pile, introducing a very difficult control problem.

The power pile which General Electric is designing will use a low-melting-point liquid metal as the primary heat-transfer medium. This liquid metal will be pumped through the pile, absorbing the heat generated and carrying it to a heat exchanger. All this part of the equipment will be very radioactive and must be heavily shielded. In the heat exchanger, water will pick up the heat, producing steam to supply a turbine. The steam piping and turbine will need no shielding.

For a better understanding of the situation, it is necessary to consider also some facts about the atomic pile itself. When an atom of U-235 is hit by, and absorbs, a sub-atomic particle called a neutron, it splits into two parts, releasing a lot of energy, and—this is most important—spills out two or three other neutrons, which then are ready to contact other atoms of U-235 and thus keep the chain reaction going. Now, less than one percent of natural uranium bears the magic U-235 label, so if we use natural uranium as a fuel the active part of the pile must be physically large.

If we use concentrated U-235, extracted from natural uranium, or one of the artificial elements, such as plutonium, or U-233, which can be produced in an atomic pile, then the active part of the pile can be made much smaller, and the factor which determines the physical size is the necessity for providing enough heat-transfer surface.

But regardless of how small we make the active part of the pile or reactor, it must be surrounded on all sides by a shield to protect personnel from deadly radioactivity. This shield must be thick and heavy—the equivalent of, say, five to ten feet of concrete. Incidentally, the intense and long-persistent radioactivity of the pile structure after it has been in operation introduces a lot of problems in maintenance. However, in our operations at Hanford we have found that these problems are not insuperable.

The heat output rate of a pile can be controlled quite easily and simply. As stated earlier, an atmosphere of neutrons is necessary to keep the chain reaction going, just as an atmosphere of oxygen is required to keep a coal or oil fire burning. Now it so happens that there are certain elements, of which boron is one, which have a great affinity for neutrons, but which simply absorb them and don't release any others. So, in the piles at Hanford there are a lot of boron-coated steel rods which can be moved into or out of the pile by remote control. To lower the power output, the operator simply pushes a button which causes a rod to move farther into the pile, so it eats up more neutrons, leaving fewer available for the chain reaction, and the power output drops. It really is simpler than controlling an oil-fired boiler.

Yes, control is easy, but there are still a lot of technical problems to be solved in building a power-producing pile to operate at the high temperature necessary for good efficiency.

These problems are being attacked in a number of places, including the Knolls Atomic Power Laboratory which General Electric is operating for the Government at Schenectady. This is a $25,000,000 facility, staffed by about 1400 people, of whom 250 are technical.

The power pile which General Electric expects to construct near Schenectady, for the A.E.C., was originally intended to be a small developmental land power plant. Now, however, in order to implement the present thinking of the Atomic Energy Commission as to the importance of military developments, this is being designed as a prototype of a naval-ship power plant. As had been expected, the Company's experience in operating Hanford is proving very helpful in the developmental work on the power pile.

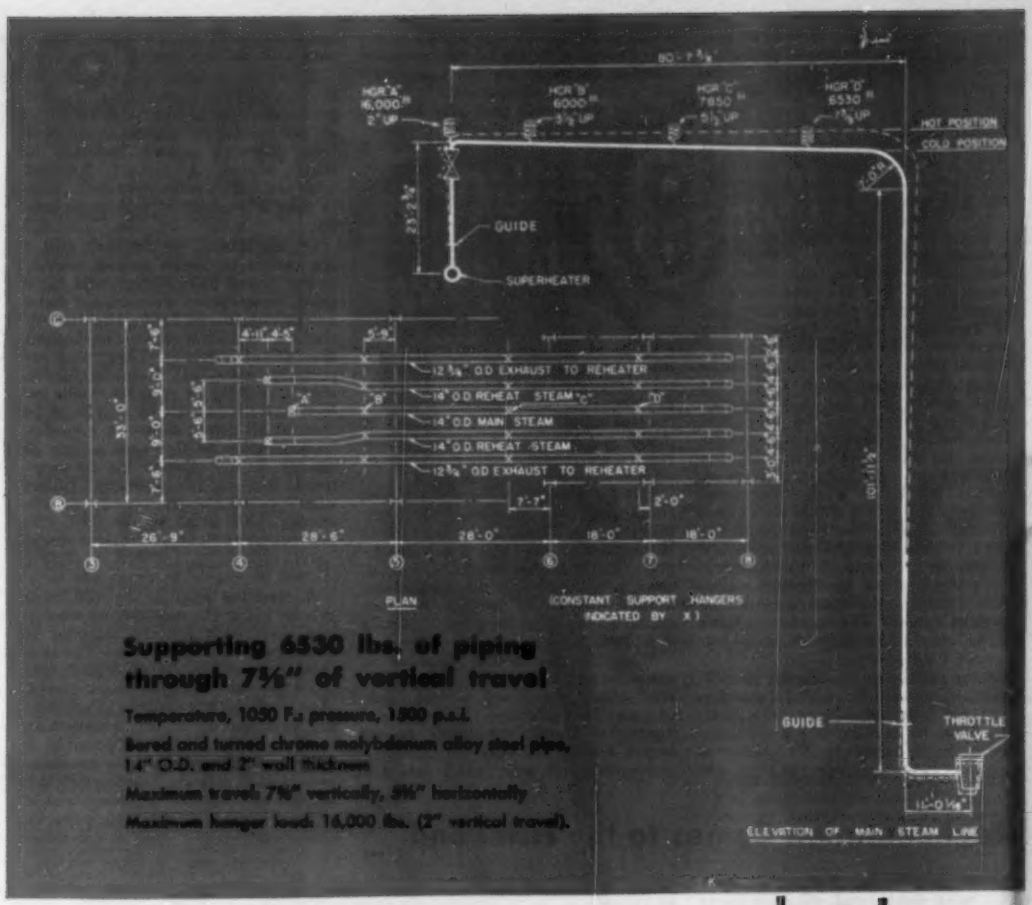
I am certain that our technical problems will be solved. If that statement is taken at full face value, then probably at least four major questions arise in mind. First, is there enough atomic fuel; second, how many dollars; third, when; fourth, how much government control? Let's consider these briefly.

I believe we shall have an adequate atomic-fuel supply in the long-term future. Uranium is a fairly abundant element. Although presently known concentrated deposits are few, methods are being developed for working the low-grade ores. True, the fissionable U-235 constitutes only 1/140 of natural uranium, but here is where breeding and conversion come in.

As mentioned earlier, when a U-235 atom grabs a neutron and spilts, it releases from two to three more neutrons. Now only one of these is needed to split another U-235 atom and thus keep the chain reaction going. The remaining one or two can go wandering around in the pile looking for other playmates. If one lands on an atom of U-235, the much more abundant kind of natural uranium, an atom of plutonium is produced, and plutonium is a fine atomic fuel. So we have used up one atom of fuel, released its energy, but have in addition a new atom of fuel.

In the piles at Hanford we are doing just about this, but we believe it is possible to build a pile which will be a real breeder and, on the average, use more than one of the extra neutrons for new fuel production. If we can do this we shall generate power and end up with more atomic fuel in the pile than we had at the start. Furthermore, the much more abundant element thorium can be converted to fissionable material in the same way. So I think we can have plenty of fuel. Consider also that the energy from one pound of fissionable material is equal to that from burning about 2½ million pounds of coal.

Now we come to cost, and this item we know but little about. A recent A.E.C. paper states that the average cost of presently planned experimental reactors is something over $10,000 per equivalent electrical kilowatt output. Not exactly cheap! But that should not discourage us. Fifty years ago the theory of the gas turbine was known just as the theory of the reactor is today. But suppose the building of a



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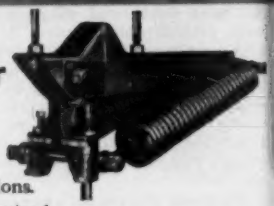

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power-producing gas turbine at that time had been a command performance, like the development of the atomic bomb. I imagine the buckets and combustion chambers might have been made of platinum! What do you think the cost per kilowatt of such a unit would have been? And that's about where we are today in the atomic-power field.

And now, when? In my opinion, a long time—twenty to forty years perhaps before atomic energy can have any effect on our electric-power industry. Developmental power-producing piles probably will be operating within three to five years—we hope to have a ship-propulsion prototype going by that time—but the bigger piles will come more slowly, and the real time-determining factor will be economic. Tremendous governmental expenditures can accelerate remarkably the development of a gadget such as an atomic bomb, or a developmental power plant, but I think we cannot greatly collapse the time cycle for the economic development of such a fundamental phase of an industry. Let's think of the gas turbine again. Would millions of dollars expended in development fifty years ago have made it economical within a few years? I think not.

Fifty years ago the needed knowledge of materials and fabrication was not available. More than that, the tools to develop this knowledge were not in existence. No industrial x-rays, no spectrographs, no arc welding, no stainless steels, no electric furnaces. Some of the metallic alloying elements we use today had not even been discovered.

What new tools and new knowledge do we need in order to build economical atomic-power plants? I don't know, but I am willing to bet that our engineers and scientists will find out in the decades to come!

Well, let's assume it is, say 1975, and that we can build and operate atomic-power plants at competitive costs. Can these be free from rigid government control? I think so!

Under present conditions, with practically all of the country's production of fissionable material going into bombs, and with such emphasis on secrecy, it is obvious that the government will retain complete control of all reactors. Even so, it could sell to utility companies any electricity generated, or even steam, or heat in some other form.

But I cannot conceive that present conditions will continue for very many years. There must be a limit to the useful size of a bomb stockpile. Our potential enemies will, in time, probably know as much about atomic energy as we do—possibly more! So the need for secrecy should disappear.

When atomic bombs become as common and widely spread as T.N.T. and other munitions, I see little chance for effective international control of atomic energy. If we are smart enough to find a means for preventing all war, then international as well as national control may become unnecessary.

So, in the reasonably near future, I visualize the opportunity for the government to discontinue entirely, or nearly so, its operation in this field, allowing private industry to forge ahead. I cannot forecast whether our government will wish to take advantage of this opportunity.

On the whole, for the long pull, I am optimistic about atomic energy in the power field. Today, and for a good many years to come, it need not be considered as a competitor of coal and oil. But utility executives should not forget it. They, and especially some of their engineers, should, insofar as possible, keep informed on progress in this field so that, at all times, they can give due consideration to this new source of energy. In my opinion the development will be evolutionary, rather than revolutionary, and atomic energy will only supplement and not supplant coal and oil as fuels.

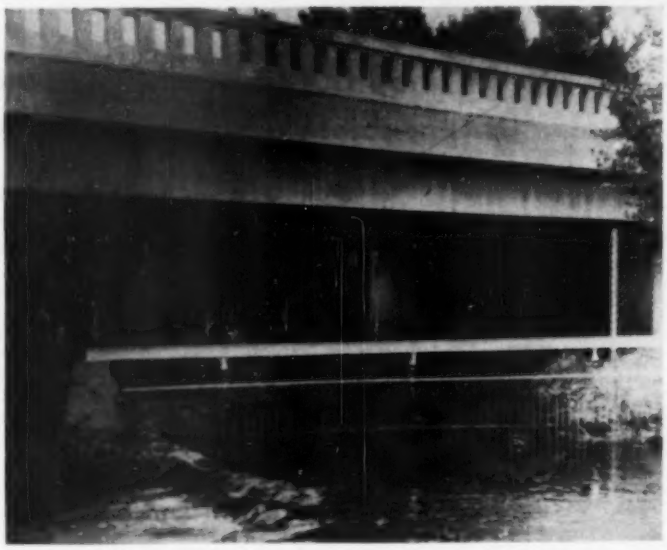
A MACHINE said to be the most precise known to engineering science has been built for the purpose of cutting diffraction gratings. The new machine can cut 30,000 equidistant lines per inch on glass coated with aluminum, and is capable of producing gratings up to six inches long in three days. If it were possible to cut lines on paper, this machine could cut 25 straight lines equidistant to .001 of .001-inch on the straight edge of a piece of cigarette paper.—Ohmite News.

Regimentation Comes to the Fish Pond

FOR MANY years attempts have been made and in some cases with considerable success, to herd groups of people along predetermined lines. The Iron Curtain set up by Russia gives complete proof of the power required to keep the sheep in line. If such herding of articulate Homo sapiens can be accomplished, what chance do the poor fish have.

Through electronic research a new device has been developed called a Shock Stick or electric wall, which effectively controls the movement of fish in well-defined channels. An electronic generator, developed jointly by Henry T. Burkey and the Westinghouse Electric Corporation, together with a screen electrode, produces a special wave form which charges the water area around the screen.

Water and debris easily pass through the screen but, when the fish hit the charged area, they receive a series of mild, harmless shocks which turn them away instantly. By this method of control large quantities of fish are saved from destruction, and maintenance of equipment, using water power, is reduced.



This Electric Fish Screen installed on the Truckee River in Nevada turns fish away from the Abbey Irrigation Canal at Reno. Similar applications prevent the loss of valuable fish in hydroelectric plants

New ENGINEERING BOOKS

Introduction to Atomic Physics by Otto Oldenberg. First Edition; 6⅛ by 9¼ in.; 366 pages; cloth; illustrated; published by the McGraw-Hill Book Co., 330 W. 42nd St., New York, 1949.

The title of this book is an excellent description of what this book really is. It is an introduction. Most recent books on atomic physics begin almost immediately with a consideration of nuclear forces and the structure of the nucleus. This book begins not with the nucleus but with atomic theory itself. The first chapters are concerned with the structural matter as revealed in chemistry. These chapters discuss the existence of the elements, the existence of atoms, the quantitative analysis of gases by volume, valence, atomic and molecular weights, the kinetic theory of gases, and material dealing with the masses and sizes of the atoms.

From there the book goes on to discuss the structure of electricity—that is, the evidence showing the existence of the electron. It describes Millikan's experiments, Richardson's equation and saturation current and space charge current in vacuum tubes. Next the book goes on to discuss the structure of light and the electronic structure of the atoms. This naturally involves the theory of spectra and the relations of the theory of spectra to the periodic table of the elements.

Only in Part VI do we come to the subject of nuclear structure. Part VI consists of five chapters—one on Isotopes; the second on Natural Transmutation and Radioactivity; third, Artificial Transmutation and Radioactivity; fourth, Applications; and fifth, Cosmic Rays. Among the applications is the uranium bomb and the uranium pile. Finally, in Chapter VII, there is a consideration of the Wave Nature of Matter.

This book is intended for readers who have taken a one year introductory physics course and are familiar with the elements of chemistry. Calculus is not necessary for the understanding of atomic physics on the introductory level. Here the difficulty is not of a mathematical nature. It is difficult, however, to understand how thoroughly our detailed theory of atomic structure, although apparently remote from observed facts, is based on experimental evidence. Therefore, in this book the relation between theory and observed facts is stressed throughout.

In other words in this book the main emphasis is on understanding as opposed to accepting on authority. In many chapters of the book a method is applied that the author has tried out in elementary and advanced courses. Certain arguments that are essential parts of the course are related to problems. Through difficult problems the student is guided by a set of questions. This method serves two purposes—it is intended to stimulate the interest of the student and it impresses the student with the physical idea that is given in the problem as distinguished from the mathematical performance through which he is asked to go by himself.

In short, this is a very excellent book for those who wish to obtain a good background of atomic physics and who have not had very much training along these lines. Dr. Otto Oldenberg is Professor of Physics at Harvard University and the material in the book is based on a lecture course offered at Harvard University.

• • •

Out of My Later Years by Albert Einstein. First Edition. 5¾ by 9 in.; 282 pages; cloth; published by the Philosophical Library, Inc., 15 E. 40th St., New York, N. Y.; 1950. Price $4.75.

This second volume of collected essays by Albert Einstein covers a period of about 15 years from 1934 to 1950. The first anthology, published under the title, The World As I See It, comprised material from 1922 to 1934. In presenting this new collection of essays by the distinguished physicist, the publishers have made available Einstein's views as the philosopher and as a man. It is a treasure of living thought and a striking record of the titanic achievements of one of our most eminent contemporaries.

Albert Einstein does not belong to that group of scholars who live in the ivory tower of their research work, oblivious to

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the world around them. On the contrary, he has always been an astute and critical observer of the trends and needs of his time. Indeed, frequently did he intervene by written as well as spoken appeal and always we should like to emphasize for a humanitarian cause.

The various parts of this volume deal with personal credos, politics, education, the Jewish issue, war and peace, and also the fundamental principles of Physics. In several chapters the author explains his theory of relativity in such simple terms as to be understandable by every intelligent person. None of the essays were written before 1936, and many of them have never before been published in any form.

The book indicates that Albert Einstein's life and work are not confined to the problems of science alone. He is endowed with the awareness of the most urgent questions of modern society, social, religious, educational and racial relationships.

• • •

Principles of a New Energy Mechanics by Dr. Jakob Mandelker. First Edition; 6 by 9½ in.; cloth; illustrated; 73 pages; published by the Philosophical Library, 15 East 40th St., New York, N. Y.; 1949. Price $3.75.

This book presents an entirely new conception of the whole body of science known as energy mechanics. This new mechanics, as the author points out in his preface, has been evolved from the same basic relations as Einstein's special theory of relativity, though not in the sense of his so-called postulates. The central notion of classical mechanics, the mass m, has been replaced in this mechanics by the superior energy conception of matter, mc^2. This important conception imparts its own higher order value to the new mechanics which conforms fully with the relativity principle, includes classical mechanics as a particular limiting case, and turns out, moreover, to be valid for high velocities.

The most significant result here is the new kinetic energy formula of a definite upper limit—something wholly unsuspected hitherto—which coincides exactly with the value for the radiating energy. While the new formula shows the classical value in the first approximation, it is entirely different from Einstein's kinetic energy formula.

This new energy mechanics represents the next step of an evolution leading from Newton's classical mechanics through Einstein's relativity theory as an intermediate stage.

As explained in the preface, in this new mechanics the result of Fizeau's experiment is precisely confirmed. Furthermore, the Lorents transition formula appears as a self-evident result, as does the dual character of force for rest and for motion. Moreover, the wave-corpuscular aspect of matter is presented in an entirely new light, differing from De Broglie's basic conception; and finally, a satisfactory explanation is given for the half-quantum value of the zero point energy according to Schroedinger's wave equation.

Dr. Jakob Mandelker is Assistant Professor of Mechanics at the Georgia Institute of Technology at Atlanta, Georgia.

• • •

The Meaning of Relativity by Albert Einstein. Third Edition, including the Generalized Theory of Gravitation; 5⅛ by 8 in.; cloth; 150 pages; published by the Princeton University Press, Princeton, New Jersey; 1950. Price $2.50.

This is the third edition of Mr. Einstein's classic presentation of his theory of relativity. The first edition, published in 1923, explained both the special and general theories of relativity and comprises the main body of this book. In 1945, Dr. Einstein added Appendix I covering significant advances since the original publication and in this new edition Appendix II presents a new generalized theory of gravitation which attempts to interrelate all known physical phenomena. Dr. Einstein emphasizes the fact that the new theory has yet to be tested against experimental facts, but from its general characteristics he regards it as highly convincing. This publication of the generalized theory of gravitation may well rank with the original appearance of the theory of relativity as a milestone of scientific achievement.

The text of this book was first presented in lecture form at Princeton University in May 1921. Since that time Dr. Einstein has become a permanent resident of Princeton where he is a Professor at the Institute for Advanced Study. The original text of this book was translated from the German by Edwin Plimpton Adams. Appendix I by Ernst G. Straus and Appendix II by Sonja Bargmann.

Engineering Data on the Niagara Controlled Humidity Method of Air Conditioning; 52 pages, illustrated; size 8½ by 11 in.; loose leaf plastic binding, published by Niagara Blower Co., 405 Lexington Ave., New York 17, N. Y. Price $2.50.

The air conditioning method described in this booklet involves dehumidifying air by spraying into it a hygienic liquid absorbent called Hygrol. This spray absorbs moisture from the air stream, which is then delivered at the temperature and humidity required.

The book gives charts for determining dew point and dry bulb temperatures, heat loads, friction losses, capacities and dimensions of equipment. A number of flow diagrams for various cooling methods and applications, also control diagrams, are shown.

Details of the system and method of calculating installations are given. A copy of the full-sized Baileley psychometric chart is folded into the back of the book.

NEW BOOKS RECEIVED

The following new technical books have recently been received from the publishers. Complete reviews of these books will appear in subsequent issues

Steam Turbines and Their Cycles. By J. Kenneth Salisbury. First Edition, 6¼ by 9¼ in., 645 pages, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1950. Price $9.00.

Presenting the essentials of steam design of turbines from basic to the most advanced thinking—for mechanical engineer or student, or for anyone interested in the design, manufacture, testing, or use of steam and gas turbines.

• • •

Principles of Engineering Economy. By Eugene L. Grant. Third Edition, 6¼ by 9½ in., 622 pages, cloth. The Ronald Press Company, 15 E. 26th St., New York, N. Y. 1950. Price $5.00.

A study of engineering from the standpoint of cost. Although written primarily for students of engineering, it will be found useful by practicing engineers and industrialists.

• • •

Coal, Coke, and Coal Chemicals. By Philip J. Wilson, Jr. and Joseph H. Wells. First Edition. 6¼ by 9¼ in. 508 pages, cloth. McGraw-Hill Book Co., Inc. 330 W. 42nd St., New York, N. Y., 1950. Price $8.00.

An authoritative treatise on coal, high-temperature coking, recovery of coal chemicals from coke-oven gas, and distillation of tar. A comprehensive modern description of present practice in the industry.

• • •

Engineering Mechanics. By Archie Higdon and William B. Stiles. First Edition. 6½ by 9¼ in., cloth. Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y., 1949. Price $6.65.

A basic text for a two-semester course, stressing the fundamental principles of engineering mechanics and the development of the ability to apply them.

• • •

Laboratory Fractional Distillation. By Thomas P. Carney. First edition, 6½ by 9½ in., 259 pages, cloth. The Macmillan Company, 60 Fifth Ave., New York, N. Y., 1949. Price $5.75.

A complete guide for laboratory and research personnel. Provides a working knowledge of the use and limitations of fractional distillation in the preparation of pure compounds, the analysis of complex mixtures and the preliminary study of distillation theories and processes.

• • •

The Integrated Power System. By Philip Sporn. First Edition. 6 by 8 in., 157 pages, cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1950. Price $4.00.

An expansion of a paper presented in 1949 before the United Nations Scientific Conference on the Conservation and Utilization of Resources. It presents the basic principles, the components, the economic advantages, disadvantages, and limitations of the integrated power system as the basic mechanism for power supply.

• • •

Circuits in Electrical Engineering. By Charles R. Vail. First edition. 6½ by 8¾ in., 339 pages, cloth. Prentice-Hall, Inc., 70 Fifth Ave., New York, N. Y., 1950. Price $7.65.

A new unified approach to the study of electric circuits. The usual book considers d-c and a-c circuits separately. This book provides one set of steady-state circuit principles sufficiently broad to apply to all frequencies, including the zero frequency case commonly accorded separate treatment under the name of "direct current."

• • •

The Fort Loudoun Project. Technical Report No. 11. 6 by 9 in. 333 pages, cloth. Issued by the Tennessee Valley Authority, Knoxville, Tenn., 1950. Price $2.00.

A comprehensive report on the planning, design, construction, and initial operations of the Fort Loudoun Project on the Tennessee River.

• • •

Pocket Encyclopedia of Atomic Energy. Edited by Frank Gaynor. First edition, 5¾ by 8½ in., 204 pages, cloth. The Philosophical Library, Inc., 15 East 40th St., New York, N. Y., 1950. Price $7.50.

A comprehensive collection of brief explanations and definitions of concepts and terms in the field of Nuclear Physics and Atomic Energy for the scholar, researcher, teacher, librarian, student and intelligent layman.

• • •

Practical Television Engineering. By Scott Helt. First edition, 6½ by 9¼ in., 706 pages, cloth. Murray Hill Books, Inc., 232 Madison Ave., New York, N. Y., 1950. Price $7.50.

A sound and detailed engineering treatment of television, fully acquainting manufacturing and sales engineers, broadcast engineers, students and technical workers in the field with all the components of television transmitting and receiving, how they work, and how they are combined in the complete television system.

• • •

Introduction to the Transfer of Heat and Mass. By E. R. G. Eckert. First edition. 6¼ by 9 in., 284 pages, cloth McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 1950. Price $4.00.

This translation and adaptation of the author's outstanding German text will be of special interest to mechanical and engineering students. It provides an understanding of the basic physical processes and different modes of heat transfer.

• • •

Giant Brains or Machines that Think. By Edmund C. Berkeley. First edition. 5½ by 8½ in. 235 pages, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1949. Price $4.00.

An authority tells the story of mechanical brains—how they think, what they can do, and what they can mean in your future. A book intended for everyone. Every reader can select from it what he wants. He can read nearly every chapter with little reference to what goes before. An excellent book.

• • •

Facsimile. By Charles R. Jones. First edition. 6¼ by 9¼ in., 422 pages, cloth. Murray-Hill Books, Inc., 232 Madison Ave., New York, N. Y., 1949. Price $6.00.

This book brings together as much as possible of the important information available on facsimile as a communication medium for the guidance of both the user of facsimile equipment and of the technical man who works with it.

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This I Do Believe. By David Lilienthal. First edition, 5⅜ by 8¼ in., 208 pages, cloth. Harper & Brothers, 49 East 33rd St., New York, N. Y., 1949. Price $2.50.

The former Chairman of the U. S. Atomic Energy Commission sets forth his views and his belief in the principles that have made us strong in a tradition which is independent of dogma and builds upon the will of free men. A timely and important little book.

• • •

The Alchemists, Founders of Modern Chemistry. By F. Sherwood Taylor. First edition. 5⅜ by 8½ in., cloth. Henry Schuman, Inc., 20 East 70th St., New York, N. Y., 1949. Price $4.00.

A most interesting book. The author has drawn a fascinating picture of this age-long quest, and of the strange and sometimes moving figures who toiled and hoped and crystallized their experience in the poetic and artistic imagery of the alchemical texts.

• • •

Electric Circuit Theory. By H. Tropper. First edition. 6 by 8¾ in., 164 pages, cloth. Longmans, Green and Co., Inc., 55 Fifth Ave., New York, N. Y., 1949. Price $2.75.

An introduction to steady state and transient theory based on the superposition principle. It presents a unified account of some of the fundamental aspects of electric circuit theory and shows how the solution of many network problems may often be simplified by the application of a few simple theorems. The practicing engineer should find this book of value.

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Great Mistakes of the War. By Hanson W. Baldwin. First edition. 5½ by 7¾,

114 pages, cloth. Harper & Brothers, 49 East 33rd St., New York, N. Y., 1950. Price $1.50.

A leading military authority analyzes for the first time the broad and far reaching American errors which influenced the course of the war or affected the peace.

• • •

Electrical Metermen's Handbook. Sixth edition. 5½ by 8½ in., 615 pages, cloth. Edison Electric Institute, 420 Lexington Ave., New York, N. Y., 1950. Price $4.90.

Like its predecessors, this sixth edition of the Metermen's Handbook is intended to serve as a practical guide to experienced metermen in solving the variety of problems encountered in their daily work. It also provides a complete, concise, and orderly text which may be useful in training and in the development of new metermen.

• • •

Route Surveys. By Russell R. Skelton. First edition. 4¾ by 7¼ in., 531 pages, cloth. McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. 1949.

A book for the civil engineer and others concerned with route selection and location.

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An Index of Nomograms. Compiled and edited by Douglas Payne Adams. First edition. 7¼ by 10 in., 174 pages, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y., 1950. Price $4.00.

A valuable guide to over 1700 time-saving and error-reducing nomograms published in 21 fields of science and engineering. It includes chemistry, chemical engineering, mathematics, physics, hydraulics and power, electricity, electronics and radio, heating, piping and ventilating, oil and gas, etc.

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Phenomena, Atoms and Molecules. By Irving Langmuir. First edition. 6½ by 9½ in., 436 pages, cloth. The Philosophical Library, Inc., 15 East 40th St., New York, N. Y. 1950. Price $10.00.

This book By Dr. Langmuir sets forth his thoughts, observations, and conclusions resulting from a long life in the world of science. Though he has presented several hundred papers before scientific societies, this is his first book. His broad approach to the world of science is precise in detail, and covers the whole human, sociological and international aspects of modern science.

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Transient Performance of Electric Power Systems. By Reinhold Rudenberg. First edition. 6½ by 9½ in., 833 pages, cloth. McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York, N. Y. 1950. Price $12.00.

This is an enlarged edition in English of this classic German text. It deals with the transient performance of power circuits with lumped properties. Much of the treatment is based on the courses the author has given on electric machinery, apparatus, power transmission and distribution, and transients proper during the last 12 years at Harvard University.

• • •

Elementary Pile Theory. By Harry Soodak and Edward C. Campbell. First edition. 5¾ by 8¼ in., 73 pages, cloth. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1950. Price $2.50.

Presenting concisely the fundamental ideas associated with the chain reacting atomic pile. It contains the declassified material from a series of lectures given by Dr. Soodak in connection with the Clinton (Oak Ridge) Laboratories Training Program.

• • •

Patent Practice & Management. By Robert Calvert. First edition. 6½ by 9½ in., 371 pages, cloth. Scarsdale Press, Box 536, Scarsdale, N. Y. 1950. Price $5.00.

A book for inventors and executives. It presents the management of inventions and patents, from the viewpoint of the inventor and executive and in their language. The author who was formerly with the du Pont Co. as a research laboratory director and in the Patent Department of Johns-Manville Corp. is now Patent Attorney in New York City.

• • •

The Valuation of a Peaking Power Plant. By Leo Macklin and John Henry Helve. 6 by 9 in., 38 pages, paper cover. Published by the authors, 1950.

The material in this pamphlet is, in part, a thesis entitled, The Study and Valuation of a Peaking Power Plant, in partial fulfillment of the requirements for the degree of Master of Mechanical Engineering at the Polytechnic Institute of Brooklyn.

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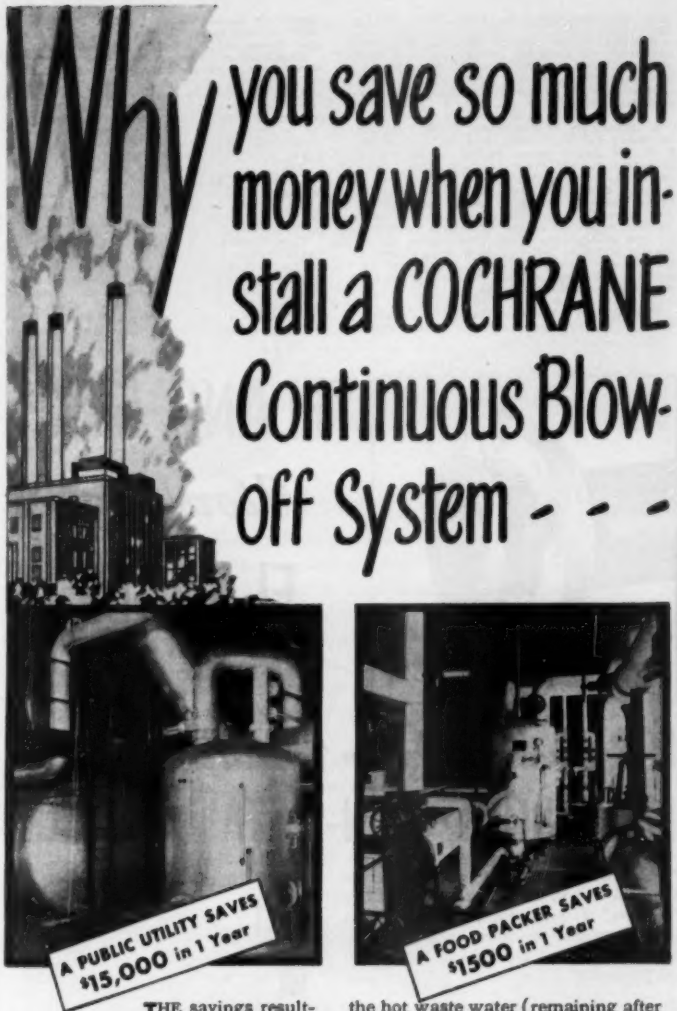
Modern Oscilloscopes and Their Uses. By Jacob H. Rulter. First edition. 6¼ by 9¼ in., 328 pages, cloth. Murray-Hill Books,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3123 N. 17th St., Philadelphia 32, Pa.
In Canada: Canadian General Electric Company, Ltd. Toronto

Inc., 232 Madison Ave., New York, N. Y. 1949. Price $6.00.

A comprehensive book bringing together a wealth of material, working facts and methods on this increasingly essential instrument to meet the needs of engineers and servicemen in many fields of industry and science.

• • •

A Dictionary of Electronic Terms. Edited by Harry L. Van Velzer. First edition 6 by 9 in., 64 pages, paper cover. Allied Radio Corporation, 833 West Jackson Blvd., Chicago, Ill. Price 25 cents.

This dictionary containing over 2500 terms used in television, radio and industrial electronics provides an accurate, up-to-date reference source of words for those in the electronics field. Definitions cover mostly modern techniques and equipment but it also contains words no longer in general use. The booklet includes over 125 diagrams and illustrations.

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Educational Motion Pictures Catalog. 6 by 9 in., 324 pages, paper cover. Published by Audio-Visual Center, Division of Adult Education and Public Services, Indiana University, Bloomington, Indiana.

This catalog listing 2280 titles of motion pictures is a biennial publication sent free to all school corporations, public libraries, and county agents in Indiana, and to all users of the Center's service both in and outside Indiana. One additional copy will be provided free for each $50 of service. Additional copies are $1.00 each. All pictures listed are 16 mm films.

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Trilinear Chart of Nuclear Species. By William H. Sullivan. First edition, 9½ by 11 in., bound in paper cover. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 1948. Price $2.50.

This elaborate publication originated in the Chemistry Division of Clinton Laboratories in 1946 and was sponsored by it and by the Argonne National Laboratory. This chart, when properly assembled, presents on a single continuous 10½-in. strip, the systematics of and physical constants data for all experimentally identified nuclear species. A remarkably splendid piece of work.

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A Survey of Electrical Insulation Practices. By Max A. Faucett, Constantine Houpe and George E. Leibinger. 6 by 9 in., 96 pages, paper cover. The University of Illinois, Urbana, Ill. 1949. Price 75 cents.

This treatise brings together the salient points of a large number of articles, books, and other technical publications on insulation. The authors have coordinated and compared various materials and their use in the light of present practices.

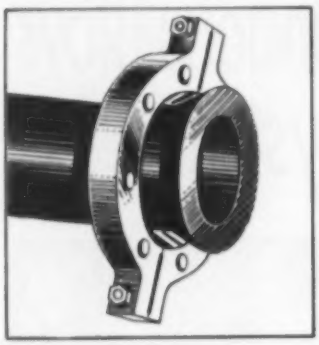
N. Y. POWER SHOW THIS YEAR UNDER ASME AUSPICES

NEW DEVELOPMENTS in the vastly important field of power will be comprehensively presented at the 19th National Exposition of Power and Mechanical Engineering in Grand Central Palace, New York, November 27 to December 2, 1950. The Power Show, as it is generally known, will be held under the auspices of the American Society of Mechanical Engineers in conjunction with the Society's annual meeting at that time.

Industrial executives and power plant operators visiting the Exposition will have opportunity to see the newest products—all under one roof. They will be in contact with thousands of engineers and others in a position to help them with problems looking toward obtaining greater plant efficiency, lower production costs and other items affecting their business.

The Advisory Committee for the exposition has recently been announced. Irving E. Moultrop, of Boston, again is chairman of the committee, and John H. Lawrence, of New York, is vice-chairman. Both Mr. Moultrop and Mr. Lawrence are consulting engineers widely known in their field. Mr. Moultrop is an honorary member of the Boiler Code Committee of the ASME and Mr. Lawrence is vice-chairman of the Finance Committee of the Society. Other members of the committee include: Lester T. Avery, president, American Society of Heating and Ventilating Engineers; John G. Bergdoll, Jr., president of American Society of Refrigerating Engineers; James D. Cunningham, president of ASME; C. E. Davies, secretary, ASME; Chester R. Earle, managing editor, POWER ENGINEERING; David Moffat Myers, consulting engineer; Joseph Pope, vice president, Stone & Webster Engineering Corp.; L. N. Rowley, Jr., chairman of the Board on Technology, ASME; Ralph A. Sherman, director at large, ASME; A. Bowman Snavely, chief engineer, Hershey Chocolate Corp.; Philip W. Swain, editor, *Power*; and Willis F. Thompson, vice president, Westcott & Mapes, Inc., who is also on meetings committee of ASME.

The exposition is under the management of the International Exposition Co. of which Charles F. Roth, manager of the exposition, is president. E. K. Stevens, associate manager, has been active in exposition management for many years.



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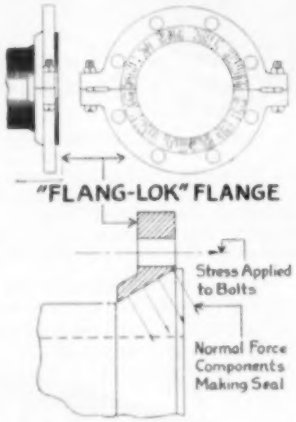
"FLANG-LOK" Flanges are designed for terminal and intermediate connections on "Goodite" Flexible Pipe, "Kemite" Duct, and other pipe or hose having "Flang-Lok" shaped ends; and for installing Goodall Expansion Joints.

The split flange is easily applied to built-up (flared) end of pipe, hose, duct or expansion joint. Flange, *only*, need be turned to align bolt holes with those in connecting flange. As bolts are tightened, rubber end of duct, etc., is compressed over broad area against connecting end, to provide a leakproof, non-metallic seal, with full orifice. Magnitude of forces forming seal is in direct proportion to stress applied to bolts.

Available in sizes up to 96", in cast iron or cast steel. *Contact our nearest branch* for complete information and prices.



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Obituaries

HERBERT E. GODFREY

THE RICHARDSON SCALE CO. regrets to announce the death of its president Mr. Herbert E. Godfrey which occurred Sunday, June 25th, 1950 at the age of 69 years. Mr. Godfrey had been associated with the Richardson Scale Co. since its inception. He was born in England where he became associated with Mr. Henry Richardson at the Avery Scale Co. Leaving England some forty-odd years ago, they came to this country and began the manufacture of automatic scales. Mr. Godfrey was secretary and sales manager of the company until 1945 when he was elected president. A widow and two sons survive him.

HERB HOLLBERG

HERBERT E. HOLLBERG, Vice President, Proportioneers, Inc., Providence, R. I., died suddenly at his home in Cranston, R. I. on July 1.

A native of Sweden and a graduate electrical engineer of the University of Sweden, Mr. Hollberg came to this country at the end of World War I and joined Rapp and Rapp, theater architects, as a draftsman. In 1924, he became associated with W. W. Ahlschlager as an electrical design engineer.

Mr. Hollberg joined Proportioneers in 1933 in Chicago shortly before that company moved to Providence as an associated subsidiary of Builders Iron Foundry. In 1934 he went to Sweden as his firm's European representative. He returned in 1938 as export manager for the company and in 1943 was made vice president of the corporation.

Mr. Hollberg is survived by his wife and son of Cranston and his parents and two sisters in Sweden.

ARTHUR LUDT

ARTHUR LUDT, a contract engineer for Combustion Engineering-Superheater, Inc., died on July 12. A native of Elizabeth, New Jersey, Mr. Ludt was fifty-six years of age and attended Newark College of Engineering. Prior to joining the Engineering Department of Combustion in 1919, he had been employed by the Singer Sewing Machine Company, the Babcock & Wilcox Company, and the Wheeler Condenser & Engineering Company. In his capacity as contract engineer Mr. Ludt was associated with some of the largest central station projects and was widely known in the power field.

BRUCE A. IRWIN

BRUCE A. IRWIN, Vice-President and General Manager of the Hammel-Dahl Co., Providence, R. I., was fatally injured on June 14th, 1950,

Packaged Boilers Deserve Good Fans, Too!

The same engineering talents and the same careful construction go into the many stack supporting draft fans we have designed for the so-called "packaged" boilers. In some ways, engineering faces more difficult design problems because of the utmost efficiency required in a relatively small space.

Green Stack Supporting Draft Fans are practical, too. They are readily accessible for inspection and maintenance. Shafts and wheels are removable endwise without disturbing the stack or other structural members.

To those manufacturing "packaged boilers" or to those operating them with fans that don't seem to be doing the proper kind of a job or where maintenance seems too high, we offer the services of our experienced fan engineers to (1) design fans suitable for the boiler or (2) study the problem and recommend the remedy.

Our New Bulletin 168 gives details of our Stack Supporting Draft Fans. Write for a copy.

THE GREEN Fuel Economizer COMPANY INC.

BEACON 3, NEW YORK

ECONOMIZERS • FANS • AIR HEATERS • CINDERTRAPS

as a result of an automobile accident.

For more than 20 years he was actively engaged in the design and development of automatic flow control valves in the chemical, petroleum and process industries. He has been associated with the Hammel-Dahl Co. since 1946.

Mr. Irwin was a member of the Instrument Society of America, American Society of Chemical Engineers, National Steam Specialty Club, Rotary Club, and was a Registered Professional Engineer in the States of Pennsylvania and Rhode Island.

BURBANK

(Continued from page 56)

ther research is going on to improve all phases of combustion and smoke abatement.

Careful attention has been given to many details of operation to make the plant easy to maintain and service. For instance, a complete overhead mono-rail system was installed with motor driven hoists and cranes. The course this rail system followed will enable all heavy equipment to be moved from place to place with ease and dispatch.

The new generator unit though having twice the capacity of the older units runs extremely quiet and even smoother than the smaller units.

The lavish use of colors, glass, and modern materials; the architectural details and theme; plus the landscaping carries the entire department into an establishment of Beauty. The community is obviously proud of its Power Plant.

MOISTURE IN COAL

(Continued from page 67)

furnace was much better than the dry coal.

Many engineers have pet theories why moisture is an aid to efficient combustion of screenings, but none of these theories can be proved. However, combustion of coal is a chemical action. All chemical action can be speeded up and made more efficient by the addition of materials which do not enter into the chemical interaction, materials called catalytic agents. Thus, water speeds up and improves the combustion of coal, without entering into the chemical reaction of the combustible and oxygen.

A good method of checking the amount of water to add is to pick up a handful of coal and compress it into a ball. If the ball retains its shape after pressure is removed, enough moisture has been added. If it falls apart, then add more moisture.

All industrial coal contains moisture to a greater or lesser degree, upon delivery to the steam plant. In recent years the practice of washing screenings and industrial coals to remove clay, slate and other incombustible matter has reduced the ash content of these coals considerably, thereby improving the burning qualities, but has also increased the variability of the moisture content. In the finer grades of screenings below ⅜ in. in particle size, this moisture content reaches as high as 22 per cent before the coal becomes saturated. As a result, the consumer was buying a lot of water. This forced the managements of well-administered steam plants to institute a well planned system of daily moisture determinations so that proper adjustments and refunds could be made to compensate for excess moisture.

How To Determine Moisture in Coal

The commonly accepted methods for moisture determinations is to sample the coal as received in the conventional manner, reducing the daily accumulation of samples to a composite sample of 2 lb, which is sent to the plant laboratory for moisture analysis. In the laboratory, this sample is ground to a particle size of ¼ in. or smaller, a 100 gram sample of this finely ground coal then placed in a dessicating oven for 12 hrs, the temperature of the oven being held at a constant temperature

Chlorinization TO SUIT YOUR NEEDS
CAPACITY 2000 lbs. Per 24 hrs.
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BUILDERS Chlorinizers are available in two volumetric models (CVS and DVS) which are identical in the way they control and meter chlorine. Differences in capacities and cabinet designs offer a selection to suit every "chlorinization" need.
Each model employs the same dependable tantalum diaphragm control valve . . . handles chlorine through vital parts in the dry, non-corrosive state . . . utilizes the Sightflo indicator which shows feed only when there is feed. For engineering information and descriptive Bulletins, address Builders-Providence, Inc. (Division of Builders Iron Foundry), 385 Harris Ave., Providence 1, R. I.
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BUILDERS makes a complete line of flow meters and controllers for liquids, steam, air, gas, and dry materials . . . mechanical and differential . . . including The Venturi Meter and Chlorinizers (chlorine gas feeders).
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of 101 C (213.8 F), the sample is then carefully weighed and the difference in the gram weight is the percentage of moisture.

In the writer's experience, the reports from the laboratory were never satisfactory. Daily moisture determinations ranged anywhere from 10 to 15 per cent and it seemed they were never high enough. Deliveries were by truck directly from the washer at the mine head, consisting of a mixture of No. 4 and 5 screenings. This coal is in transit only one hour, yet would be dripping profusely from the truck, indicating that the coal was saturated with moisture and it is generally accepted by experts that No. 4 and 5 screenings ordinarily retain in excess of 20 per cent before saturation, so the natural conclusion was that the laboratory analyses were in error. (This is not a harsh criticism of the laboratory for it is in the hands of very able technicians.) Evidently the methods of sampling and analysis were in error, so extensive experiments were conducted to determine the best method of sampling and analysis. All of these tests were so numerous and extensive that space and time do not permit enumeration, however, the end result was conclusive and satisfactory and is as follows:

Details of Sampling and Moisture Measurement

(1) A 10-lb sample is taken from each truck as it dumps its contents in the coal hopper.

(2) Each 10-lb sample is deposited in a 20-gal air-tight metal container (20-gal garbage can).

(3) Each 24-hr period, at 8:00 a.m. daily, the contents of the 20-gal container is quartered in the conventional manner, until the final quarter results in a 2-lb sample.

(4) Immediately, the 2-lb sample is processed through a manual F No. 4 Quaker City Corn Mill, being ground to a particle size of $\frac{1}{8}$ in. If ground finer, the heat of grinding evaporates too much moisture, creating a decided error.

(5) A 50-gram sample of the 2-lb sample of ground coal is then carefully weighed on a laboratory balance.

(6) The 50-gram sample is immediately transferred to a drying pan, which is inserted into a Moisture Teller (Dietert Meter) for 15 min at a temperature of 300 F. The Moisture Teller is shown and described in Fig. 1. Another moisture meter, of semi-automatic type, is shown and described in Fig. 2.

(7) As the Moisture Teller is equipped with a timer, this timer is set for the desired time of drying (15 min). When the meter shuts itself off, remove pan and weigh by moving the 1 to 10-gram slide weight on the balance to the right until a balance is obtained. The reading of the slide weight scale times 2 equals the per cent of moisture. If the

KEEP YOUR B.E. UP
YOUR COAL COSTS DOWN...

Richardson Automatic Coal Scale, Stationary, Floor Mounted Style.

1 **Richardson Coal Scales**—Low B. E. (boiler efficiency) and costly coal waste are quickly signalled, the moment they begin, when you install a Richardson Coal Scale over each boiler. You get a detailed record of coal consumption by the hour, shift, day, week or month. By checking on all forms of coal waste they help to keep your power costs at a minimum!

2 **Richardson "Monorate" Distributors**—Designed by Richardson engineers for preventing coal segregation in stoker fired installations, the curved top plate of the "Monorate," causes all coal, *lumps and fines*, to fall at the same rate. It eliminates the tendency for the mixture to separate. This insures a uniform spread over your stoker hopper . . . a prerequisite for efficient combustion.

Richardson "MONORATE" Distributor showing patented curved plate which prevents separation of lumps and fines.

A complete Richardson Installation Provides:
Leakproof Gate from the bunker, Flexible Inlet to scale, Automatic Coal Scale, "Monorate" Non-Segregating Distributor to stoker or Down-take Chute to pulverizer.

Richardson engineers will be glad to discuss your coal consumption problems. For complete details on Richardson Coal Scales write for Bulletin No. 1143. Bulletin No. 1349-P gives complete information on the "Monorate."

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Materials handling by weight

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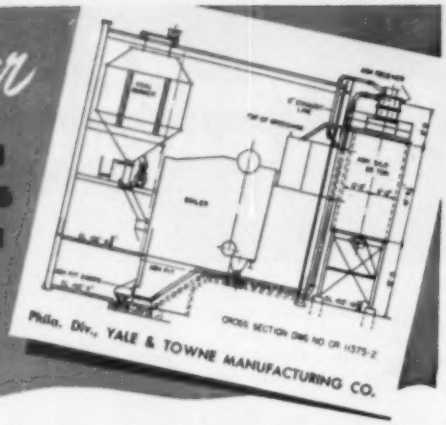
Another
COAL and ASH HANDLING INSTALLATION by BEAUMONT



Here's one of the many efficient coal and ash handling installations—designed, manufactured, installed by Beaumont. The above system is operating at the Philadelphia plant of Yale & Towne Manufacturing Company. This plant saved both time and expense—through one-contract-economy . . . But you're right! It's up to us to convince you of the advantages in a Beaumont installation: So let us send you our folder of typical installations. Write to:

Beaumont BIRCH COMPANY
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Nicholson Expansion Steam Traps

SET RECORD FOR LOW MAINTENANCE

FOR ALL STEAM OR HOT WATER EQUIPMENT

Radiators
Separators
Paper Machinery
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Kettles
Railway Coaches
Dry Kilns
Vulcanizers
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Plastic Molding Presses, etc.

- Only One Moving Part
- No Pins, Bearings, Links to Wear Out

Here is an illustration of how Nicholson's extreme simplicity is cutting trap maintenance costs. In the 2 years Bradshaw & Co. have been distributing Nicholson expansion steam traps in the Pittsburgh area they have installed 444 units. Not one order for repair parts has been received. And examinations of traps in continuous service for at least 18 months, at steam pressures to 250 lbs., have shown no valve cutting.

Other features: easily installed; discharge air as efficiently as water; no air-binding; hardened stainless steel valve, seat. Lengths, 18" to 40". Pressure, 0 to 250 lbs. without change of valve or seat.

Catalog 250 or see Sweet's

W. H. NICHOLSON & CO.
140 OREGON STREET, WILKES-BARRE, PA.

sample contains more than 20 per cent moisture, a 10-gram weight must be placed with the drying pan and added to the slide weight reading.

Summary

The important thing in moisture determinations of coal is the time element. The absorbed moisture must be retained in the coal sample until analyzed, for all the time that the test sample is exposed to the drying action of the atmosphere, it will be losing moisture, particularly in an atmosphere low in relative humidity. Therefore, it is imperative that no time be lost while the sample is exposed to the drying action of the atmosphere.

Also, in oven drying methods, 101 C. is not sufficiently high to assure complete evaporation in the absence of forced air circulation, but to raise the temperature beyond this point may cause decomposition of the coal. The short period of drying, 15 min, the heating element and forced circulation, plus the simplicity of operation, is the secret of the success of the Moisture Teller for moisture determination in coal.

CLEANING HIGH-PRESSURE BOILERS

(Continued from page 73)

solutions and overheating, condensate was admitted to the radiant superheater intermediate header to fill both the radiant and convection superheaters. Sufficient flow was maintained through the radiant superheater to provide continuous overflow from the convection superheater outlet header drain as long as fuel was being burned in the superheater furnace.

Method of Introducing Chemicals

Method of introducing chemicals was the same for all operations. Treated water drained by gravity into the mixing tank where chemicals were added and the resulting solution was pumped through the boiler fill line, the boiler feed line and economizer to the boiler. Condensate when used was fed through the boiler fill line; under these circumstances the solution from the mixing tank was more concentrated to allow for dilution by the condensate.

The trisodium phosphate was selected for the alkaline boil-out because of its proved superiority to plain caustic as a detergent and the authors' conviction that silicates and caustic have no place in the high-pressure boiler. Sodium sulfite was used to react with the dissolved oxygen in the undeaerated water and to provide reducing conditions during the boil-out. Samples of the solution taken near the end of the operation analyzed 550 ppm PO_4, 50 ppm SO_3 and pH 11.4.

The boiler was inspected on two occasions, after the strong alkaline

and after the alkalizing and surface conditioning boil-out.

After the strong alkaline boil-out, a considerable quantity of dirt and miscellaneous debris including nuts, bolts, welding rod stubs, scrapers, lamp bases, glass and metal turnings was removed from the drums and headers.

At the final inspection after the final alkalizing boil-out, the visible metal surfaces of the boiler drums, tubes and headers were clean, exhibiting the grey color of pickled steel. No rusting was seen in any location. There was no pitting evident except on the handhole caps where slight etching had occurred around the periphery of the seating surface for the stainless steel gaskets. This condition was not serious but was notably more prevalent on the caps of the upper headers. This observation led to some laboratory work on gasket corrosion described later in the paper.

Specimens of boiler tube which were placed in both the steam and mud drums just prior to the acid boil-out were in excellent condition and showed a negligible loss of metal with maximum calculated penetration of 0.0004 in. Several bushels of flaky mill scale and deposit mixed with additional miscellaneous debris were removed from the lower regions of the boiler.

CATALOG LIBRARY

(Continued from page 50)

clone" equipment (described as small-tube type of cyclonic dust collectors using centrifugal force for separating dust from gas stream) as a highly successful and economical means of separating fly ash—not as a panacea for all cinder and fly ash problems. Parts and assemblies are illustrated by photos and drawings and explained in terms of construction, operation and capacities. Particle size and its significance in fly ash elimination, is discussed in detail and so is dust collecting efficiency as affected by operating conditions. Book also contains excellent engineering data on both single and double hopper installations. Western Precipitation Corp.

262 **Dust Collectors** — Dust collecting equipment for power plants, foundries, cement plants and similar industries is the subject of Bulletin No. 1438, 36 pp. Contains many photographs of installations, also photos showing equipment being tested in company laboratories. Discusses services offered by manufacturer in analyzing individual installation requirements. American Blower Corp.

FUELS, LUBRICANTS

263 **Steam Power Plant Auxiliaries**—In Vol. 36, No. 4, of Lubrication, a technical publication on selection and use of lubricants, is an article of recommended lubrication practices for steam power plant auxiliaries. Illustrated with photos and sketches, it discusses automatic coal firing machinery, stoker design, pulverizers, tube cleaners, compressors, motors, fans and blowers, external reciprocating elements of pumps and compressors and similar subjects. The Texas Co.

264 **Diesels, Their Fuels and Lubricants** —This 46-pp book offers a well organized and attractive presentation of practical information on Diesel engines, covering their history and economics as well as discussing their design characteristics and operating principles. Classification of Diesels according to speed is explained. Other chapters cover injection systems, combustion chambers, lubricating systems, and Diesel oil purification and filtration. The balance of the book is

New Method Gives Precise Control in Air Conditioning

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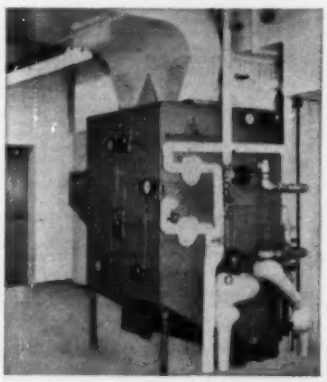
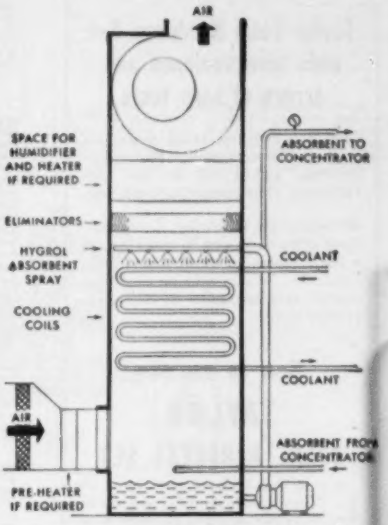
● The Niagara "Controlled Humidity Method" is a new system of air conditioning giving complete control of temperature and relative humidity, holding constant conditions or varying them at the will of the user. Especially, it provides dry air at normal atmospheric temperatures with little or no refrigeration required. A condition of 15 grains of moisture per pound of air at 85 deg. F. dry bulb temperature has been produced without refrigeration.

The apparatus is enclosed in a casing thru which the air is drawn by fans. The air is filtered and then enters a chamber where it is dehumidified in passing thru a spray of "Hygrol" Liquid (a hygienic hygroscopic chemical that absorbs the air-borne moisture and contains no salts or solids to precipitate) In the same chamber are located cooling coils which remove the latent heat of evaporation and also sensible heat as required.

The absorbent liquid spray falls into a tank at the base, where it is piped to a concentrator, removing moisture taken from the air. The re-concentrated liquid returns to the system. This process is continuous, and the apparatus operates at full capacity at all times.





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The same equipment may be used to provide winter air conditioning when required, by installing a tempering coil at the outdoor intake, an humidifier, and a reheat coil above the eliminators.

This equipment is manufactured in a range of sizes providing from 1000 to 20,000 CFM of conditioned air from a single unit, and mutiple unit installations are practical. It is expected that, by reducing the need for refrigeration, the cost of air conditioning will be reduced by this method. Applications generally are in a temperature range from 35 deg. F. upward. Below the freezing temperature of water, the Niagara "No-Frost" method is applicable.

The equipment is protected by U. S. and foreign patents. Installations have been made in food and chemical process industries, in packaging hygroscopic products, for preventing condensation of moisture on metals and other products in storage, in air conditioning for laboratory control and for human comfort.

For further information, write Niagara Blower Company, Dept. E, 405 Lexington Ave., New York 17, N. Y.

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WATER HARDNESS

Taylor Total Hardness Set ends inconvenience and errors of soap tests

Now you can test boiler water for total hardness without the inconvenience and errors of the old-fashioned, time-consuming soap test.

With this new Taylor Set, determinations of hardness can be made in just a few minutes on waters up to 1400 p.p.m. . . . it can also be used as a control test on zeolite or lime-soda treated waters.

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1. Merely place the 50 cc. sample to be tested in a 250 cc. flask with 2 drops of Taylor Hardness Indicator and 1 cc. of Taylor Hardness Buffer.
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3. When the color changes to blue the burette reading in cc. is multiplied by the control factor, in this case 20, to give you the total hardness.

Since one simple titration with Versenate does the whole job, you get your determination faster and easier. Since the color change provides positive visible evidence of the end point, your reading is far more accurate than the soap test method.

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devoted to a discussion of fuel and lubricating oil required by Diesels and description of company's products. Book is filled with photos, sectional illustrations and schematic drawings and includes table showing relation of engine performance characteristics to fuel properties. Sinclair Refining Co.

265 Fuel Oil Treatment—By text and sketches, this folder points out undesirable conditions in the storing, pumping, heating and burning of industrial fuel oil and the correction of these conditions by company's fuel oil treatment. Defines sludge and includes instructions for application of the fuel oil treatment. E. F. Drew & Co., Inc.

OTHER EQUIPMENT

266 Concrete Floors Q & A — A new booklet titled Lumnite Concrete Floors—Corrosion Resistant and Heat Resistant, has just been published. The detailed information contained in this booklet brings up to date, the service experiences and late developments in this field. The information covers methods and materials used in placing corrosion resistant concrete in a wide variety of industrial applications. Typical uses of corrosion resistant concrete are listed for many industries and also given, are the answers to a number of questions often asked about it. Lumnite Division, Universal Atlas Cement Co.

267 Purger Bulletin—How air and other non-condensables get into refrigeration systems; the adverse effect of this on operating costs and efficiency and what manufacturer's forged steel purger does to prevent it are covered in 8-pp Bulletin 192. Also included are installation data with illustrations and diagrams, specifications and prices, helpful charts and tables. Armstrong Machine Works.

268 Welding Fittings and Flanges—Titled "Catalog and Engineering Data Book 211," this handsomely bound 262-pp manual provides complete dimensional data, weights and prices on company's welding fittings and flanges. The engineering section contains practical, illustrated information covering welding fittings and flanges under varying conditions of temperature and pressure, location and materials processed. Discusses their use in different piping systems.

A section is devoted to welding fittings and flanges in special metals and alloys and their specific applications. The technical section covers properties of pipe, rating of pipe, fittings and flanges, line expansion and flexibility, support and anchorage of piping and flow of fluids.

Distribution of this excellent piece of industrial literature is limited to major users, designers and erectors of industrial piping. (Please include your title when requesting it.) Tube Turns, Inc.

269 Transmission Belting — Catalog M-9022, 28 pp, gives detailed design, engineering and performance data on manufacturer's line of transmission belting. Tables on belt speeds, arc of contact, friction, horsepower correction, and service factors are included in the manual, together with hints on proper selection of a belt and procedure for analyzing belt drives. Illustrations include many photos of belt installations and drawings of transmission drives. United States Rubber Co.

270 Steels for Hot Spots — This is an 88-pp manual filled with information on steels for elevated temperature service. Includes a discussion of the general principles of high temperature behavior of ferrous materials and the factors influencing their behavior; a data section replete with tabular and graphical material covering mechanical property values of 21 steels; and illustrated description of major high temperature testing facilities in the United States, and a comprehensive bibliography of company's technical publications on the properties and use of steel at high temperatures. United States Steel.

271 Technical Data on Plexiglas — This is a file folder of technical and application information on Plexiglas sheets, rods and molding powders, covering their workability, physical properties, available thicknesses. Includes data sheets on the uses and advantages of Plexiglas in large area lighting, typical designs of coffers, photos of installation and a discussion of room lighting. Rohm & Haas Co.

272 Wired Television—Illustrated Bulletin 1025, 16 pp, introduces company's Utiliscope, a camera and monitor type of equipment designed to enable an observer to see where he can't look. Some of the many applications for this wired television which are described and illustrated include viewing instrument readings at remote points, checking boiler water levels, watching coal flow in chutes, watching hazardous laboratory tests, checking furnace ignition. Diamond Power Specialty Corp.

273 Pump Packings—Packings for use on reciprocating and centrifugal pumps are illustrated by photo and described in this 4-pp folder. It covers packings for practically all services and includes a table of recommendations to facilitate selecting the right packing for any particular application. Johns-Manville.

274 Rubber Expansion Joints — This 8 page bulletin AD 137 tells about the application, construction, styles, service and advantages of the company's line of rubber expansion joints. Other information given, includes "How To Order" and a table of dimensions which is accompanied by dimensioned line drawings. The Garlock Packing Co.

275 Flanges for Severe Service — This 4-pp bulletin describes and illustrates a flange specially developed for services involving severe abrasion and corrosives, and for use in suction and discharge service. Photos and sketches illustrate the flange and its parts. Bulletin also covers a flexible rubber pipe for use with abrasive or corrosive material, as well as an acid- and corrosion-resistant duct, listing solutions this duct will handle. Goodall Rubber Co.

277 Water Gages — Eight-page Bulletin E-1 covers line of water gages for stationary and locomotive boilers, marine and refinery service and tanks for all pressures and temperatures. Listings include photos of all gages, sizes and construction details. Bulletin S-3, four pages, covers gage glasses, glass guards, sight flow indicators and related equipment. Ernst Water Column & Gage Co.

278 Temperature Measuring Instruments —For all those responsible for the safe operation of electric power equipment, this company has just issued a revised 34 page catalog ND4-33-461 describing the company's instruments for measuring the temperature of generators, motors, condensers, transformers, etc. The bulletin covers a wide variety of instruments, portable and automatic indicators, for checking in any order on temperatures. Reference also is made of new and specialized instruments for measuring in rapid succession a number of bearing temperatures. Leeds & Northrup Co.

279 Spreader Stoker Selection — Fourteen-pp Form P-320-A16M is intended to help those choosing a spreader stoker to get the most for their investment, and it points out many factors to be considered in the selection. It pictures and describes in detail the principle operating parts of manufacturer's stokers, emphasizing their advantages. Includes engineering drawings and photos of typical installations. American Engineering Co.

280 High Speed Conveying—This 12-pp folder, although pocket sized, opens out to present a check chart helpful in selecting the right conveyor. Covers loading, unloading, elevating, piling and transporting and spreading operations, referring to manufacturer's model best suited for each job. Includes sketches illustrating combinations of units as well as available types of housings, flights and carriers. Baughman Mfg. Co., Inc.

281 Water Hardness Test—This technical bulletin presents a test procedure for determining hardness of water, by use of a color indicator which is described as both easy and accurate. Instructions for running the test are illustrated in color. Includes prices of company's complete hardness titration set and individual solutions used. W. H. & L. D. Betz.

282 Car Spotter — Book No. 1902-A, 16 pp, illustrates and describes car spotters in three types and two sizes for a variety of car moving jobs, many of which are illustrated by photos. Book contains photos of various models, dimensional drawings, electrical characteristics, weights and prices. Also covers accessories for use with spotters—rope, hooks, sheaves and snatch blocks, as well as drum type car pullers for heavy duty service. Link-Belt Co.

283 Fluid Reduction Mills — Bulletin 430-1, 8-pp, introducing company's fluid energy reduction mill, discusses the advantages of finer particle size in many processing operations. Illustrates the mill

and explains its grinding operation. C. H. Wheeler Mfg. Co.

284 **Rotary Tube Cleaners** — Bulletin R-105 presents air and water driven rotary tube cleaners and cleaner accessories. Illustrates several models and heads, discussing special features. Also includes data on motors and hose for use with cleaners. Roto Div., Elliott Co.

HELPFUL BULLETINS

(Continued from page 36)

ing principles, characteristics of operation, temperature sensitive bulbs, recording charts, and accessories. Resistance type thermometers, humidity instruments, and time-temperature controllers are also described. In addition to photos, the book is liberally illustrated with reproductions of actual temperature chart records and sketches of applications. The Bristol Co.

WATER TREATING

129 **New Clarification and Softening Method**—Contact reactors that utilize an old chemical laboratory principle—that of previously formed precipitates added in the form of sludge and slurry acting in the manner of catalytic agents to accelerate chemical reactions—are described and illustrated in 16-pp Publication 5001. Explains how reactors work to accomplish successful utilization of the sludge contact process and describes both round and rectangular types. Lists 11 important applications of this method ranging from clarification of surface waters for industrial and municipal purposes to removal of iron and manganese from well waters. Pictures several installations and discusses use of auxiliary equipment. Cochrane Corp.

130 **Two-Stage Water Conditioner**—Bulletin 4801 describes company's water conditioner which combines the advantages of both hot process and zeolite softening. Explains operation of softener in which the first stage is the hot process using lime or Dolomitic lime and the second stage in which zeolite softener reduces hardness to zero. Discusses advantages of the combination—silica reduction, low alkalinities, lower CO_2 in steam, lower costs and tells applications to high pressure boiler plants. Cochrane Corp.

METALS

131 **Steel Color Code Chart**—To assure positive identification of steel purchased from this company, a code chart printed in full color is available. It shows color markings used on more than 50 types of stock, including hot rolled and cold finished alloys, stainless, hot rolled and cold finished carbon steels, and plates and structurals. United States Steel Supply Co.

132 **Modern Metallurgy**—Compiled for industrial users of iron and steel castings, this 28-pp illustrated bulletin provides extensive information on the chemical composition, mechanical properties, heat resistance and other characteristics as well as applications of 12 ferrous alloys. Tells company's facilities for producing basic materials, casting and finishing machine parts. Hunt-Spiller Mfg. Corp.

133 **Hard-Facing Manual**—This newly-published handbook should prove a helpful guide to power engineers interested in prolonging the life of parts and equipment. It tells the complete story of hard-facing. Describes how to select the right alloy; which welding process to use; and gives simple, step-by-step instructions for applying the various rods by both the oxy-acetylene and metallic-arc welding processes. Information is given on the properties and available sizes of 12 hard-facing materials. Haynes Stellite Div., Union Carbide and Carbon Corp.

OTHER EQUIPMENT

134 **The Why, What and How of Lubricants**—Here's a 20-pp booklet explaining the commonly used tests and terms describing lubricants. Covers such factors as viscosity, flash and fire, neutralization number, penetration, specific gravity, extreme pressure, steam emulsion and corrosion. Includes glossary of 100 lubrication terms and lists products manufactured by company. Although factual enough to suit the person who specifies lubricants for the plant, this book is written in layman's language and is illustrated with drawings showing the various tests described—as well as amusing sketches giving at-a-glance interpretation of their meaning. Tide Water Associated Oil Co.

135 **Traffic Cops for Speed Drives**—Book 2349, 8 pp, introduces a new line of automatic speed controls for use with company's PIV variable speed drive, which are designed to automatically control output speed range. Describes and illustrates the four available types—electronic, pneumatic, hydraulic and mechanical. Includes diagrams of job engineered applications covering some of the many industrial uses for these controls. Link-Belt Co.

136 **How to Choose and Use Air Traps**—Bulletin 202, 4 pp, describes manufacturer's complete line of air traps, covering their selection and installation for automatic drainage of moisture from compressed air intercoolers, aftercoolers, receivers, separators, and drip points. Illustrations of the various airtrap models, their applications and how they work are also presented, and physical data and list prices included. Armstrong Machine Works.

137 **Matting Selection Data**—What you should know about floor matting is told in three new catalog sections. Section 6120 on runner matting describes and pictures corrugated mattings, "Ezy-Kleen" matting, spike resistant matting, multi-link matting, fiberised counterway matting, "Durotred" matting, sponge-back corrugated matting, and a flexible Korcseal type especially valuable where oil and chemicals are prevalent, traffic heavy and service constant. Data and specifications included on each type. Section 6100, on perforated matting, describes its construction and outlines types of application for platform, standard, and special perforated mats, includes specifications. Section 6110 describes utility mats. The B. F. Goodrich Co.

138 **Care of Drills and Reamers**—Here's an excellent 24-pp, pocket-size handbook on tool care. It's clearly worded and generously illustrated, and its chapters cover grinding and crankshaft drills, speeds and feeds, use of oils and compounds, car-

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bide drills, reamers. Includes a table of cutting speeds. It is said that if the recommendations made in this book are followed, longer life from cutting tools and lower production costs will result. Recommendations cover tungsten carbide tools as well as those made from high speed steels. Chicago-Latrobe.

139 Proportioning Oil Burner—Featuring the eight major operating advantages of company's proportioning oil burner, Type BI, Bulletin 901 also provides dimensions, capacity tables, shutter and support data. Illustrated with typical layouts and installations. The Anthony Co.

140 Tractor for Tough Jobs—A tractor which, through the use of a hydraulic torque converter drive, delivers higher average horsepower and does more work over a given period, is described in 22-pp Form MS-426-504. Illustrated with photos and cutaway drawings, the bulletin discusses the hydraulic torque converter drive in detail, also other construction features and design details of the tractor—its diesel engine, injection system, temperature control etc. Also describes ease of operation and maintenance, gives full specifications. Allied equipment and accessories are also pictured. Allis-Chalmers Mfg. Co.

141 Plant Equipment—Maintenance Catalog 550, 36 pp, presents a wide range of power transmission equipment, as well as slurry pumps, water valves, roller holdbacks, perforated screens and elevating conveyors. All equipment listed is for heavy duty service. Complete descriptions are provided, supplemented with photos, dimensional drawings, data tables and specifications. Where dimensions must be given by purchaser, listings of data needed are shown. McNally Pittsburgh Mfg. Corp.

142 Converter Data—Catalog 303, 10 pp, provides essential engineering information on company's line of converters designed especially for use with hot water heating systems and covering those for use with radiant heating systems as well as standard hot water systems. Fully documented with selection charts and tables. Patterson-Kelley Co., Inc.

143 Improved Concrete Construction—"15 Steps to Better Concrete Construction," is a 12-pp illustrated booklet providing detailed information and specifications on company's compounds engineered to answer specific problems of concrete and masonry construction. Describes use of a retarding densifier to render structures resistant to water, cracking and absorption, keep water content, concrete quality and setting time uniform regardless of atmospheric temperature, even during hot weather. Discusses 14 other materials for coating, sealing, hardening and repair work on concrete and masonry. Includes product descriptions and composition, specific uses, contributing properties and specifications. Sika Chemical Corp.

144 Locomotive Crane — Specifications and construction details covering a 25 ½ Diesel electric locomotive crane, in which deck operations are accomplished by Diesel power and travel is by electric motors mounted in each truck, are presented in Catalog 6000 L-8, 4 pp. Photos show crane at work, also underside and topside assembly. American Hoist and Derrick Co.

145 Heat Exchangers—Illustrated Catalog 1149, 8 pp, presents shell and tube heat exchangers of both single-pass and double-pass design, with removable tube bundles. Includes dimension tables and diagrams, instructions for figuring oil and water cooling capacities. Photos show several installations of these exchangers. Young Radiator Co.

146 Air Handling Progress—Bulletin 4224 is Vol. 5 in company's collection of advertisements showing how air handling equipment serves public utilities and various industries. Contains some 40 pp and includes many photos of installations. American Blower Corp.

147 The Possibilities of Teflon—This is a 12-pp booklet on the applications and properties of Teflon—tetrafluoroethylene resin. Discusses design considerations pertaining to its use in gaskets and packings of many types, which offer chemical inertness, toughness, and excellent electrical properties. Polychemicals Dept., E. I. du Pont de Nemours & Co.

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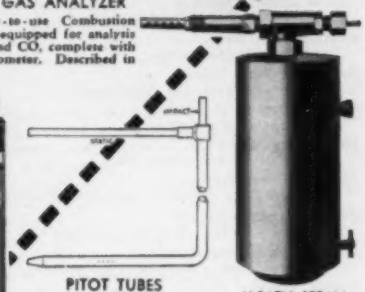

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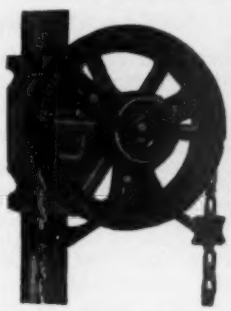

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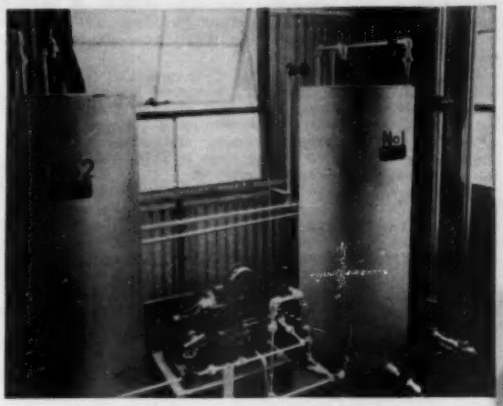
MILTON ROY "Packaged" SYSTEMS



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MILTON ROY COMPANY
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POWER PLANT CONSTRUCTION NEWS

Pueblo, Colo.—Colorado Fuel & Iron Co., iron and steel products, plans expansion and improvements in power plant at mill, with installation of additional equipment for increased capacity. Cost reported over $1,500,000. Proposed to carry out work soon.

Brunswick, Ga.—Georgia Power Co., Atlanta, Ga., plans new steam-electric generating station at Brunswick, initial unit reported to cost about $5,000,000, with turbine-generator, high-pressure boilers and auxiliary equipment. Proposed to begin work soon.

East Chicago, Ind.—American Cyanamid Co., 30 Rockefeller Plaza, New York, N. Y., industrial chemicals, etc., plans boiler house at proposed new plant at East Chicago, for production of catalysts for petroleum industry. It will consist of several large processing and other structures. Entire project estimated to cost close to $3,000,000. Completion is scheduled in about 12 months.

Harrodsburg, Ky.—Printz-Biederman Co., 1974 East 61st St., Cleveland, Ohio, women's coats and suits, plans boiler house at proposed new converting plant at Harrodsburg, where site is being secured. Work will comprise a main three-story building, 100x350 ft, reported to cost approximately $300,000, with equipment.

Locke Mills, Me.—E. L. Tebbets Spool Co., Locke Mills, turned wood products, plans boiler house in connection with rebuilding of mill destroyed by fire several months ago. Work has been authorized and will be placed under way soon. Cost reported about $250,000. Company is a subsidiary of Ekco Products Co., 1919 North Cicero Ave., Chicago, Ill.

Detroit, Mich.—Fisher & Co., Fisher Bldg., real estate, plans boiler plant for central-heating service in new 10-story office building at West Grand Blvd. and Second St. Entire project will cost about $10,000,000. Albert Kahn Associated Architects & Engineers, Inc., New Center Bldg., Detroit, is architect and engineer for structure, which will be known as Brothers Bldg.

Grand Rapids, Mich.—American Box Board Co., 407 Market St., S.W., box board, chip board, etc., plans boiler house at new converting plant for manufacture of corrugated fibre boxes and containers, comprising a large one-story building and several auxiliary structures. Cost reported about $1,000,000. Work will begin at early date.

Kosciusko, Miss.—Superior Coach Corp., Lima, Ohio, motor buses, school buses, etc., plans boiler plant at proposed new branch factory at Kosciusko, where site is being secured. It will comprise a main one-story building, about 150,000 sq ft floor space, for parts production and assembling. Cost reported close to $1,000,000. Work is scheduled to begin at early date.

Napanoch, N. Y.—State Bureau of Contracts and Accounts, State Office Bld., Albany, N. Y., plans power plant at State Institute for Male Defective Delinquents, Napanoch. Cost reported close to $1,000,000. Bids are scheduled to be asked early in fall.

Cliffside, N. C.—Duke Power Co., Charlotte, N. C., plans expansion in steam-electric generating station at Cliffside, with installation of new turbine-generators with rating of 130,000-kw, high-pressure boilers and auxiliary equipment. Company also will make extensions in River Bend generating station, including installation of additional equipment for increased output. Entire project reported to cost about $12,000,000.

Goldsboro, N. C.—Carolina Power & Light Co., Raleigh, N. C., has authorized new steam-electric generating station at Goldsboro, with initial capacity of 60,000-kw. Work will begin in near future, with completion scheduled early in 1952. Cost reported over $8,000,000, with transmission lines and other operating facilities.

Roanoke Rapids, N. C.—Virginia Electric & Power Co., Richmond, Va., plans new hydroelectric generating plant on Roanoke River, vicinity of Roanoke Rapids, including power dam, power station, artificial lake and other facilities, with extensions in transmission lines. Cost reported about $27,000,000. Application is before Federal Power Commission, Washington, D. C., for permission to proceed with project.

Athens, Ohio—State Dept. of Public Welfare, State Office Bldg., Columbus, Ohio, plans new central-heating plant at Athens State Hospital. No estimate of cost announced. H. G. Allen is architect for Dept.

Hamilton, Ohio—City Council, Hamilton, plans extensions and improvements in municipal steam-electric generating station, with installation of new 10,000-kw turbine-generator and auxiliary equipment. Also plans new power substation and extensions in transmission lines on west side. Estimates of cost being made. Emery, Marker & Emery, Toledo Trust Bldg., Toledo, Ohio, are consulting engineers.

Troy, Ohio—Braun Brothers Packing Co., Troy, meat packers, will build boiler house at new processing and packing plant on 35-acre tract of land on Dye St., fronting on Miami River. It will consist of several large production buildings and is estimated to cost approximately $1,000,000. Construction is scheduled to begin soon.

Shawnee, Okla.—Sylvania Electric Products, Inc., 500 Fifth Ave., New York, N. Y., radio and television tubes, fluorescent lamps, etc., plans power house at new plant on Benedict St., Shawnee. Project will include a main one-story building, about 50,000 sq ft floor space, and several auxiliary structures, and is reported to cost approximately $1,500,000.

Anderson, S. C.—Singer Sewing Machine Co., 149 Broadway, New York, N. Y., sewing machines, plans power house at new assembling plant at Anderson. It will consist of several large one-story buildings for different branches of operation, with facilities for employment of about 1000 persons. Cost reported over $2,000,000. Project will be carried out by Poinsett Lumber & Mfg. Co., Pickens, S. C., a subsidiary interest.

Greenville, S. C.—Maverick Mills, Inc., 144 Addison St., East Boston, Mass., cotton fabrics, plans boiler plant at new branch mill at Gantt Station, near Greenville. It will comprise a main multi-story modern windowless-type structure, with complete air-conditioning system, and auxiliary buildings. Cost estimated close to $4,000,000. Completion is scheduled in summer of 1951.

Freeport, Texas—Dow Chemical Co., Freeport, magnesium, industrial and other chemicals, plans new power plant at local works, in connection with a number of new manufacturing units. Entire project estimated to cost about $30,000,000, with power station to represent investment of about $850,000, including equipment. Main offices are at Midland, Mich.

Richmond, Va.—Virginia Electric & Power Co., Richmond, plans extensions in steam-electric generating station at Drewrys Bluff, with installation of new turbine-generator, high-pressure boilers and auxiliary equipment. Cost reported about $12,000,000, with extensions in transmission lines.

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Fig. 83

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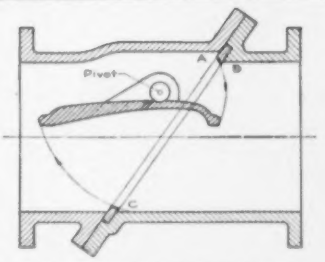
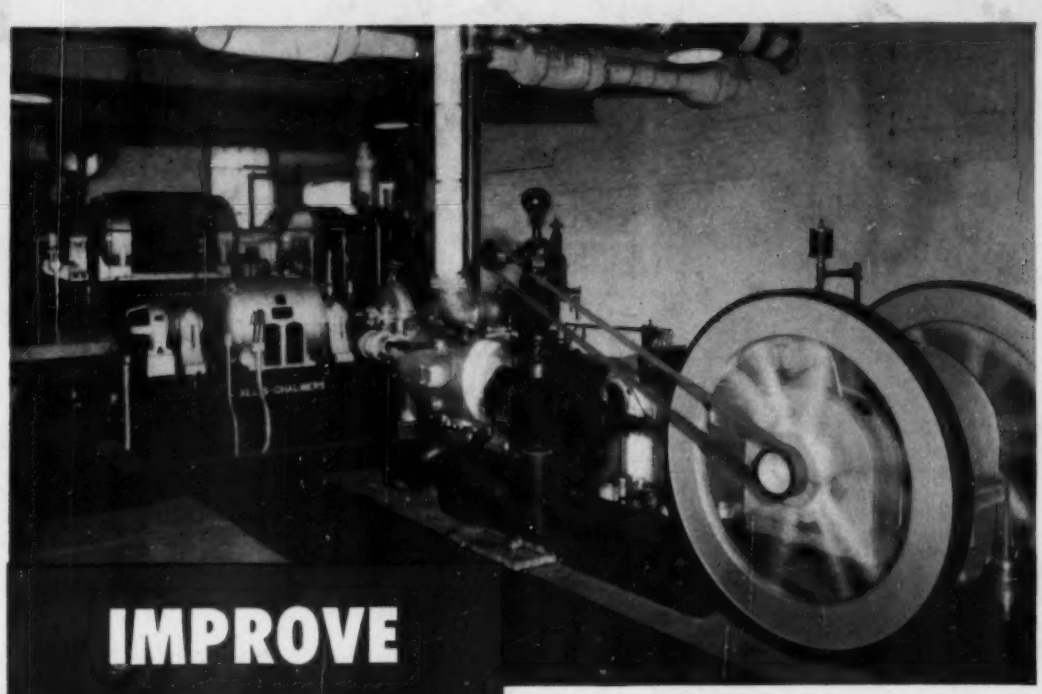


Cross-section of the Chapman Tilting Disc Check Valve illustrating the way that the balanced disc is supported on the pivot, with arrows showing the travel of the disc. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.



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